INCREASING CARBON SOIL SEQUESTRATION ON PUBLIC LANDS

OVERSIGHT HEARING

BEFORE THE

SUBCOMMITTEE ON PUBLIC LANDS
AND ENVIRONMENTAL REGULATION

OF THE

COMMITTEE ON NATURAL RESOURCES
U.S. HOUSE OF REPRESENTATIVES

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OVERSIGHT HEARING ON INCREASING CARBON SOIL SEQUESTRATION ON PUBLIC LANDS

Wednesday, June 25, 2014

U.S. House of Representatives

Subcommittee on Public Lands and Environmental Regulation

Committee on Natural Resources

Washington, DC

The subcommittee met, pursuant to notice, at 2:06 p.m., in room 1324, Longworth House Office Building, Hon. Rob Bishop [Chairman of the Subcommittee] presiding.

Present: Representatives Bishop; Grijalva, Holt, Garcia, and Huffman.

Mr. BISHOP. All right, the hearing will come to order. The Chair recognizes the presence of a quorum—barely.

The Subcommittee on Public Lands and Environmental Regulation is meeting today to hear testimony on increasing carbon soil sequestration on public lands. Under the Rules, the opening statements are limited to the Chairman and Ranking Member. However, I ask unanimous consent to include any other Member's opening statement in the hearing record, if submitted to the clerk by the close of business today.

[No response.]

Mr. BISHOP. And, hearing no objection, so ordered.

STATEMENT OF THE HON. ROB BISHOP, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF UTAH

Mr. BISHOP. I have long been impressed by the success of some of our agricultural operations in my state. The Utah Deseret Ranch, for example, is admired for both its solid economic performance, as well as the ways it has improved the environmental quality of the land. Recent scientific research on how plants sequester atmospheric carbon in the soil and the benefit that it provides are verified wisdom of this ranch's management regime.

So, we are learning that scientifically managed grazing can increase soil carbon sequestration, and lock it away for long periods, while also increasing the land's productivity and cattle, and wildlife, and natural resilience.

Today we are going to hear from rain scientists and other experts on the state of the science and the real-world results that occur when these new management regimes are put into practice. We are also going to hear whether or not these practices are more widely applicable on the public and private grazing lands, and whether or not the benefits of improved grazing techniques can be achieved on an economically sound basis. And if the answer is yes, then atmospheric CO2 sequestration in soils holds the potential to be an exceptionally cost-effective way to address many of the concerns of those who see climate change as our overriding threat.

If pulse grazing and other related agricultural practices really will sequester carbon while also increasing soil health, drought tolerance, biological diversity, and resistance to wildfires, we truly have a win-win situation.

Now, importantly, unlike some policies that are advocated by those who see catastrophe only, the changes in agricultural practices called for by today's witnesses will neither further bind our economic activity nor will they reduce our freedoms, but will increase the productivity of agriculture on public and private lands, without adding more bludgeons and back-saddles to the arsenal of regulatory overloads here in Washington.

With that, Mr. Grijalva, do you have an opening statement you would like to make?

Mr. GRIJALVA. Thank you, Mr. Chairman, I do.

STATEMENT OF THE HON. RAÚL GRIJALVA, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF ARIZONA

Mr. GRIJALVA. Thanks again for holding this hearing, and for allowing us to make an important—to have an important discussion on climate change, and what could be done to mitigate the impacts of manmade greenhouse emissions. While we do not agree on the exact premise of the hearing, we do feel it is important to have a direct conversation about climate change. And this hearing validates that it does exist, and that steps must be taken to mitigate that.

Climate change is not a democratic, liberal, or even a regional-specific issue. It is a bipartisan issue that affects the entire world, and Congress cannot afford to ignore it.

Former George W. Bush Treasury Secretary Hank Paulson published an Op-Ed earlier this week in the *New York Times*. He warns of a climate bubble, wrecking havoc on our economy and environment, and urges immediate action. Climate change is bigger than winning elections or scoring political points. It is our society's biggest challenge. Primarily thanks to the executive action under President Obama, we are making some serious advances to offset and limit carbon emission, but there is much more we need to do. This hearing is a good place to start.

President Obama's 2013 Climate Change Action Panel highlighted the carbon storage potential of our public lands—and there may be opportunities to improve our storage capacity with prescribed grazing techniques, as we will hear today from today's witnesses. Unfortunately, it is not that simple. Grazing comes with baggage.

As we saw with the recent Bundy debacle in Nevada, grazing on public lands can be a very contentious issue, to say the least. Talking exclusively about grazing and carbon soil sequestration sidelines, the most critical aspect of public land grazing. Ranchers on public lands pay a $1.35 per animal unit, a rate that is substantially lower than many private and state lands. It is so low that the Federal Government pays more to manage the grazing program than it receives—than it received in return through fees.

The artificially low fee is a taxpayer subsidy to the grazing industry, and that does much more harm than good. In Fiscal Year 2004, the last time the Government Accountability Office studied grazing, the BLM and Forest Service spent $115 million more than was collected in fees. If we are going to have a realistic conversation about grazing and how it can or cannot improve carbon soil sequestration, we have to talk about all aspects of Federal grazing programs, including the ridiculously low fee.

Bundy made grazing both a viral and toxic issue, but we can't walk away from the reality. Taxpayers, our constituents, are being ripped off, and we are not doing anything about it. Welfare queens like Bundy are—with a million dollars in old grazing fees, continue to use the public lands at no expense to them or to that industry.

Whether this hearing is about climate change or grazing on Federal lands, there is more that this committee needs to do. We need to hold hearings and consider legislation, both about how we reform grazing and how we deal with—and climate change. Committee Democrats have requested several hearings on aspects of climate change, an issue that is particularly salient for those of us who come from the West, the arid West, in my portion of the country. We did not request this hearing, but hope that it signals the end to the moratorium on climate change-related hearings. I look forward to hearing from our witnesses.

At the appropriate time, Mr. Chairman, with your concurrence, if Mr. Huffman could introduce Mr. Wick, who is from his district. And I yield back.

Mr. BISHOP. I am excited to have the four witnesses who are here on this particular panel that are going to help us to think differently about some of these issues we have had before, which is what we desperately need.

So, I am happy to introduce at the panel already, Mr. Steven Rich from Salt Lake City; Dr. Richard Teague, from Vernon, Texas, from the Texas AgriLife Research; Supervisor Tommie Martin from Gila County in Arizona; and Mr. John Wick, from Palo Alto, the Marin Carbon Project, who I believe, Mr. Huffman, is your constituent. And if you would like to give a further introduction, I recognize you now for that.

Mr. HUFFMAN. Well, thank you very much, Mr. Chair and Ranking Member Grijalva. Thanks for having this hearing. I think we are in for a very interesting discussion this afternoon. And it is my great pleasure to welcome my friend, John Wick, from Nicasio Native Grass Ranch. He is the co-founder of the Marin Carbon Project, which, I am proud to say, is located in my district, and I believe is doing some truly pioneering work on this subject.

The Marin Carbon Project is a consortium of agricultural institutions and producers in Marin County that includes a suite of university researchers—that is the Palo Alto connection—and also county and Federal agencies and non-profit organizations.

The overall vision of the project is for land owners and land managers of the agricultural ecosystems to serve as stewards of soil health, and to undertake carbon farming in a manner that can improve on farm productivity and viability, enhance ecosystem functions, and, believe it or not, thinking very big, these folks believe you may even be able to stop and reverse catastrophic climate change. Through their innovative and extensive research, John and his collaborators have demonstrated that practices, seemingly simple practices, such as applying compost to topsoil, can have powerful impacts, increasing carbon storage on agricultural lands.

So, Mr. Wick, thank you so much for being here, and thanks for your leadership and expertise. I look forward to hearing more about the pioneering work and research coming out of the Marin Carbon Project.

And I thank you, Mr. Chair.

Mr. BISHOP. Thank you. Now we will get to the people who know what they are talking—go actually to the panel themselves. We will start with Mr. Rich and just go down from left to right.

Everything that you have written is already part of the record. We appreciate that. Anything you want to add to it will easily be added as part of the record. This 5-minute oral presentation part is limited to 5 minutes, and then we will have, obviously, other times to ask your questions where you can go on.

I would ask you to watch the monitor in front of you. When it is green that means everything is kosher and wonderful. When it goes to yellow, you have 1 minute, so talk really fast. And when it goes to red, that is when I ask you to stop.

So, with that, Mr. Rich, your written testimony is there, we are ready for your oral testimony. You are recognized.

STATEMENT OF STEVEN H. RICH, SALT LAKE CITY, UTAH

Mr. RICH. Thank you, Mr. Chairman, Ranking Member Grijalva, members of the committee. Thank you for this opportunity. I would particularly like to compliment Chairman Bishop for recognizing the potential of what we are here to present today to improve the public forests and range lands, while also sequestering vast amounts of atmospheric carbon.

I am President of Rangeland Restoration Academy, but I am testifying here as an individual, not on behalf of the Academy. I draw on over 40 years of experience as a rancher, author, environmental and resource management educator, and as a consultant on ranching rangeland and forest management. For several years, the Academy and others have been developing what we are convinced is a win-win solution to the current controversy over how to deal with rising atmospheric CO2 levels. I want to stress that we speak from solid experience and extensive research.

This approach is proven, widely demonstrated, cost-effective, rapidly scalable, and extraordinarily beneficial, both economically and environmentally. In fact, compared to all other options, I am convinced it is the only practical, economic, and politically viable option for dealing with CO2. I have laid out the case supporting these assertions in more detail in my submitted statement. But in these few minutes let me give you a sense of the scope, potential, and benefits of this win-win solution.

The key to this approach is optimizing the natural process of soil carbon sequestration that has existed as long as there have been terrestrial green plants. Soil carbon is the basis of ecosystem health. Biodiverse grasslands, grass shrub lands, and grass grazable woodlands store much more total carbon in a much more stable form than any other ecosystems. Proper grazing is the key to the health of these ecosystems. Recent research and worldwide, on-the-ground experience have given us a much better understanding of how optimizing livestock and wildlife grazing work as a necessary part of a health soil community made up also of plants, symbiotic fungi, microbes, and other soil organisms, all acting together to greatly accelerate carbon sequestration.

The scope is immense. We can now calculate that it is completely possible to sequester in the soil all of the CO2s released in the atmosphere by human activity since the beginning of the Industrial Revolution to the present time. Dr. Teague is among the scientists whose work verifies this potential.

In addition to solving the CO2 emissions issue, there are a number of other benefits. These include increased forage for wildlife and livestock, improved wildlife habitat, enhanced ability to recover threatened endangered species, increased biodiversity generally, restoration of healthy watersheds, improved utilization of natural precipitation to help better deal with droughts, better water quality, enhance flood control, and others.

The same techniques will vastly improve forests as CO2 sinks have added benefit of greatly reducing the risk of massive megafires that are now releasing massive amounts of CO2 and methane into the atmosphere annually. Supervisor Martin has personal experience with this, and will address it in more detail.

All of these benefits can be achieved on the public lands and forests with relatively minor changes, and current management practices. The Academy is developing the proposal that the Federal Government set an example for the world and sequester the worldwide carbon footprint of the Federal Government on the public lands and forests. It can be done, but I am convinced that to do this, or anything else of value, it will require Congress to direct that these management changes be made.

The unfortunate reality is that many current Federal rangeland and forestry management policies not only prohibit these best management approaches, but in many circumstances are actually accelerating the deterioration of the rangeland and forest hills.

In summary, Mr. Chairman, what I am now advocating is not new. And, in fact, in many ways it mirrors the most successful management practices of Native Americans. They preserve the biodiversity that has been steadily eroding since European settlement. It works with nature to restore ecosystem integrity. The many benefits to the public lands will then automatically follow. Much of our public lands are rapidly deteriorating under present management. This approach may well offer the last, best chance to reverse that trend and deal with a divisive and contentious political issue at the same time. There really is no downside to this approach. Much more information is posted on RangelandRestorationAcademy.org, including the longer written statements of these witnesses.

I look forward to discussing this further with the committee.

[The prepared statement of Mr. Rich follows:]

PREPARED STATEMENT OF STEVEN H. RICH, SALT LAKE CITY, UTAH

Mr. Chairman, I wish to thank the committee for this opportunity to share some of the best possible news those who care about Federal public lands, our Nation and the future could receive. I wish especially to thank you, Mr. Chairman, for recognizing the potential of soil-carbon-based ecological restoration principles to the future of Federal lands and that of the world.

While I will refer in this statement to the work of the Rangeland Restoration Academy, which I serve as president, I want to make it clear that I am testifying here as an individual, not representing the academy. As you will see, I think instituting various aspects of the policies which will increase atmospheric carbon sequestration on the public lands will require legislative action by Congress and the academy does not engage in lobbying or political activities.

We have described atmospheric CO2 sequestration in soils as a "Win-Win Solution" because it genuinely bridges the wide, divisive sometimes shrill divide over climate change and its causes. For those who feel that rising atmospheric CO2 levels are a lethal threat to humanity and nature—it should be truly wonderful news that the clear, scientifically established potential to actually solve the problem—planet-wide—really exists. This is done simply by using a few optimal management changes—which are proven to create genuine ecological and biodiversity restoration and vastly increase carbon-sequestration! It has the added advantage that, in my opinion, this is the only political, economically proven solution that can be instituted within the timeframe that those concerned about climate change say must be met.

The fact is that some agriculturists have for many years been doing things that greatly accelerate the rate of the land-based carbon sink's photosynthesis-sourced soil storage on rangelands, farm lands and grazable woodlands! This can be ramped up to the point of securely sequestering *all human-sourced carbon emissions from the beginning of the Industrial Age to the present day*.[1] This should be met with universal rejoicing—not least because soil carbon is the basis of ecosystem health.

On the other hand, those who object to very painful economic damage imposed by an emissions-control based policy—which will most certainly be quickly overwhelmed and negated by emissions from India, China and elsewhere—should also be very happy. They can solve their "opponents" problem by healing nature. All people of good will love nature. Soil carbon sequestration genuinely and sustainably restores vast, long-lost biological and economic potentials—making positive differences of an order of magnitude and more. There is no rangeland or forest problem that is not improved by optimal soil relationships and more soil carbon. Public lands which can rapidly store carbon also make the difference between thriving rural economies in public land states and a series of dependent, impoverished economic basket cases whose young people must move away.

CO2 sequestration in soils is accomplished by the most ancient of plant processes—making sugar through photosynthesis. On land, "sugar-for-minerals and water" trading alliances between photosynthetic algae and fungi, such as in lichens, soon developed. Modern scientific discoveries about almost universal, win-win symbioses between complex plants and certain fungi—the "Liquid Carbon Pathway"—have allowed us to understand how leading livestock operators, farmers and researchers have managed to restore soil carbon levels from perhaps .5 percent to 5 percent (which represents a 1,000 percent increase in water-holding capacity) in a decade or less—vastly less time than anyone, including the "experts," supposed.

Glucose (simple sugar)—made in a plant's leaves from sunlight, water, and CO2—is routed in liquid form through the plant's supporting tissues to its roots. Some of this is simply flooded out from root-hairs into surrounding soil for the support of nitrogen-fixing bacteria, etc. and other plants. Most plant's roots allow fungi's root-hair-like hyphae to enter them. The fungi have connections to myriads of further-specialized soil bacteria and other organisms which trade the mineral, etc. results of their specialties with the fungus. Since fungus-connected plants get much-increased mineral nutrition and water through the support of this complex, fungal-connected symbiosis, plants tied to such "fungal guilds" (again, trading alliances) are able to produce up to 40 percent more "photosynthate" (sugar) to support themselves and the rest of the soil community than are lone plants. The symbiosis often involves many thousands of plants exchanging nutrients through "fungal mats", one of which may cover several acres. "Long Fallow Disorder" describes the puniness of crops grown in soils lacking proper fungi and other soil-symbionts—where the mats have died.

Within the vast soil volumes occupied by these mats, one recently discovered, sticky "glycoprotein" (made of protein and sugar) called glomalin, coats massive tonnages of the fast-growing, short-lived hyphae of VAM (Vesicular Abuscular Michorrhyzae) fungi. Glomalins from dead hyphae stick soil particles together in discrete globules—creating life-necessary "soil structure" which allows air and water

[1] Dr. Christine Jones and others make this statistical projection of a near-term worldwide solution using various sequestration rates and assumptions, based on worldwide experience.

to both penetrate and collect. They create the sweet smell from dark, rich soils. Glomalins make up a significant part of soil carbon. With the mineral-getting help of bacteria stimulated by liquid carbon, these and grazing-stimulated pulses of remains from dead plant roots and other soil life (78 percent of the total) are quickly "humified" in tough, plastic-like long-chain polymers (sort of like brown coal), in highly water-stabile forms that can last thousands of years. The deeper in the soil structure they lie, the more invulnerable they are.

Ranchers in tall-tree locations (perhaps 20 inches precipitation) report 2 to 15 tons and more of CO2 sequestered per acre annually, depending on several variables. The above sequestration figures, for example, come from recovering, once-degraded soils with an *apparently* accelerating deep-sequestration trend. This range is widely documented to be more than the animals respire, etc.

Less rainfall and shorter growing seasons do mean less photosynthesis—so, less carbon stored. But that's where the soil carbon magic kicks in. Annual growth of a dry-climate (let's say 8 to 10 inches precip.) short-grass like Blue Gramma or Sand Drop-seed can vary by 1,000 percent or more. With fungal-guild help—the growth varies less and has higher averages. Functionally, grazing animals are an indispensable, key part of fungal guilds, when properly managed. Simply stated, the greater soil symbiosis activity triggered by grazing animals that eat, dung and urinate on a site for a brief time—then leave until plants grow back grazed their tissues—make the plants and the soil community bigger and healthier.

The term "Pulse Grazing" (root pulses, above) describes grazing methods designed to optimize the natural deposition of tremendous tonnages of dead root hairs, etc. in soils—caused in nature by any removal of living, above-ground grass, etc. tissue (grazing, fire, insects, disease, etc.)—and by their death due to normal seasonal dormancy or drought. These root hairs, etc. are replaced during growing seasons. They grow back into improved, more carbon-rich soils, and are necessary to soil carbon storage and to feed decomposer organisms in the humification process.

Timing is critical, both in terms of length of the grazing event and the length and recovery effectiveness of the prolonged rest periods between grazings. The concept includes pulses of grazing and resulting dung, urine and animal hoof track deposition, etc., designed to both simulate natural effects of migrating herds and simultaneously cause great, cyclic increases (pulses) of bird, insect, fungal and other populations in response to these concentrated resources. Pulses of seedlings are also produced, supplying a steady stream of new plants to fill open or expanding niches.

These relationship dynamics, in time, allow the site to transcend progressively higher biological thresholds without more precipitation—progressing from bare ground and dry-country-adapted annuals, to struggling, weak perennial xerophytes (desert plants) to strong specimens of the same species groups, to a more complete xerophytic community with many species, located in less-productive sites—to taller xerophytes in better sites—then to the spread in favored locations of more mesic species (requiring damper soils—like western wheatgrass)— even to hydrophytes (water-loving, riparian species) as watersheds heal.

In wetter regions and higher-altitude areas, managing livestock by methods described below also create this entirely natural, "no-cost", very profitable, restoration of native plant, etc. biodiversity. In Missouri, for example, locally extinct Tall Grass Prairie plant species have returned to played-out, eroding, carbon-poor farm soils by ranchers simply controlling timing, intensity and frequency of livestock grazing in response to weather, etc. (in pulses). These species typically have a 12 foot deep root zone and can sequester carbon at great depths in very high volumes. There are public lands in the East and other locations where these and other highly productive plants are native (In the West, stands of Great Basin Wild Rye Grass, Giant Sacaton and other tall species reach up to 9 feet in height and have very deep roots).

Without planting a single seed, without using a tractor, any fertilizer, herbicide, etc. (all normally used when introducing Tall-Grass species) the ranchers simply let whatever weeds and grasses remain in the poor soils to grow—as high as 6 feet and more, let the highly concentrated livestock eat some and trample the rest, covering and protecting the soil from that time forward. This sets the stage for a series of other species—as above. As fungal mats and soil life communities and processes re-established in the natural course of these scientifically guided, adaptive operations (guided primarily by the landowner) the Tall Grass species reappeared—by themselves! They grew from "hard seed". Hard seeds are plants' "species survival time capsules", genetically programmed to remain long-dormant in soil seed banks, germinating only when highly favorable soil conditions reappear—in this case after a hundred years.

The community's biological processes move toward the optimal in response to "simulated native animal behavior". This optimized, "naturalized livestock" grazing behavior—within many fungal guilds, is absolutely necessary in forming very large versions of what researchers Augustine, McNaughton and others call "grazing lawns". This works best of all when stock are trained to eat a variety of "less-desirable" plants—thus removing semi-toxic plant's competitive advantage versus grasses, etc. (Yes, livestock can indeed be trained to engage in certain grazing behaviors.

Overlapping grazing lawns represent an extremely valuable restoration opportunity for most adapted native organisms. Optimizing (generally, shortening) the time of plant's exposure to grazing pulses by domestic stock, limiting grazing to moderate levels, and evening out the grazing pressure per acre deeply minimizes risks to plant survival. It also periodically "jump-starts" the fungal guild and functionally joins separate grazing lawns into "grazing lawn areas" of hundreds to thousands of acres.

Grazing lawns have higher-carbon, high-nutrient-level soils, therefore—unlike dry-climate soils without grazers— they produce plants of high nutrient value for animals. These—though grazed, are not grazed so repeatedly as in unmanaged nature—so plant diversity is not limited—as it is in unmanaged sites—to species having the highest grazing tolerance.

These optimally managed landscapes typically produce growing—even locally dominant—populations of species like high-value grasses, shrubs and forbs (flowers) which poorly tolerate repeated grazings without sufficient recovery time. These "progressively restored" landscapes are produced by grazer/plant/fungal-guild relationships which—very often—cannot occur at all without active, skilled, human-intelligence-directed grazing management. *Such management always includes adaptive, highly variable livestock herd sizes and other strategies to mitigate the effects of highly variable rainfall, etc.*

More soil carbon means bigger plants, more seed production and therefore more seedlings and closer plant spacings—cooling the soil and facilitating further sequestration. As a growing series of positive feedbacks continue to occur and strengthen, the site will be progressively colonized by larger grasses (etc.)—like the Sand Drop-seed's much larger cousins (3 to 4 feet tall), Tall Drop-seed or Spike Drop-seed. These have much deeper root systems, provide more leaf-litter when trampled and more shade when standing, cooling the soil further.

Cooler soil greatly benefits carbon storage and all other biology. Taller grasses and forbs can draw water and nutrients from deeper soil layers. So, then, can the fungus and the guild—and carbon-storage goes even deeper. When this happens, average production on the above 8″ to 10″ rainfall site—and all wetter ones—increases greatly. In dry lands this makes place for far more animals of far more kinds, such as insects, rodents, birds, deer, pronghorns, etc. This also means far less rainfall "runoff" (after a period of time almost none) and much more soil-water storage. Lands managed in this manner do not experience droughts as being as functional severe as lower-carbon lands and are far more resilient.

Fortunately there has been significant progress in remote sensing technology using satellite image data. This can even act as a "Time machine" documenting plant community changes since the 1970s. When known management changes result in huge meadow expansions into former sagebrush, for example, when such has not happened on adjacent ranches, this can be explained in terms of improved watershed conditions—which always means more soil carbon. Changes in density as well as growth or shrinkage of various plant species populations can be derived from the data and correlated to carbon levels under various plant communities through "ground truth" sampling. This should lead to effective soil carbon level carbon monitoring on public lands by averaging samples taken in similar communities on vary large acreages. It effectively and economically allows good monitoring of carbon sequestration rates on landscape scales.

Federal agencies are required to document the condition of the vast public lands. Those in "fair' condition and better are able to sequester soil carbon at varying rates. A tragically large percentage, however, that is now in degraded states, actually lose soil carbon to the atmosphere due to erosion and other processes. By contrast, well-managed Aspen groves, for a positive example, can produce over 2,000 lbs. of herbaceous understory biomass per acre in addition to the tree tissue above and below ground. The combined sequestration potential is immense. Clearly, Aspens and herbaceous plants coexist as supportive symbionts.

In every non-wetland location, higher soil carbon means more soil water. In most ways, this is the functional equivalent of being in a higher rainfall zone. But, in Western Federal lands which have degraded—often due to policy errors described by Dr. Teague, and others related to woody-species management (following), *this soil water rescue must now begin at the very-harsh, bare-soil-surface level before soil carbon sequestration can proceed again*. One source of documented degradation is massive, west-wide increases in the stem density and canopy cover of semi-toxic woody shrubs and tree species like conifers and sagebrush. When the least-healthy end of these burn, they degrade far further, still because of the negative effects on the soil.

These dense stand structures were triggered by several causes, among them pioneer-era, etc. overgrazing, followed by very active fire suppression after the mass-removal of most semi-toxic-woody-plant-eating sheep and goats, plus the simple competitive advantage of being taller and less-palatable-to-animals.

Fact: as these stands thicken beyond functional thresholds, they literally kill most other plants by hyper-competitive strategies. *This means the end of the most productive grass-mycorrhizae pathway to soil carbon sequestration in very large areas*. Springs dry up as a result. Entire perennial streams cease all but flood flows. Also, the animals that depend on these plants must leave or die. *This catastrophe, unknown to the public and media, leads to 90 percent and greater losses in overall site-adapted biodiversity and triggers a cascading loss of biological values*. Vast reaches of pinion/juniper woodland, sagebrush steppe, chaparral, etc. range sites are in such conditions. They are depauperate biological deserts.

Too-dense tall conifer (firs, spruces, etc.) stands also have no grass, etc. understories. Studies published in "Nature" in 2008 indicate that such thick, unmanaged (since 1930), "wilderness-type" conifer forests *actually store around 30 percent less tree-tissue carbon than do far less-dense forests restored to the fewer, healthier, faster-growing and vastly more fire-safe, mainly large trees of ancient Native American management practices*.

Reducing tree densities to pre-Euro-settlement levels has also been shown to end the bark beetle scourge that has killed tens of millions of too-dense conifers. The deaths of these un-harvested trees must now set off a series of events *leading to millions of acres of horrifyingly severe future ground fires burning in tens of millions of acres of then-fallen timber. Burning in perhaps hundreds of thousands of acres per fire event—most of these huge fuel loads of fallen, beetle-killed trees will certainly be completely consumed in close contact with soils—utterly sterilizing them—while killing any regrowth of conifers, aspens and other resprouters, as well as the herbaceous plants. This will, within hours, release* all *their combined carbon stores, including vast amounts of methane and nitrous oxides, into the atmosphere*.

Resulting from well documented deep soil sterilization and soil-carbon-vaporizing effects of severe fire, the hydrophobic (water-shedding) crusts they develop, with the massive 7- to 14-year flooding periods and huge soil erosion that develops as a result—it should be noted here that many hillslopes with southern and western exposures, for example, many never produce forests again. Mountain soils are often thin anyway. Severe losses may foreclose some potentials forever.

Present, rapidly rising wildfire emissions in western states now typically equal those of the transportation sector. Again, the emissions from burning live trees are a small ratio of the totals almost instantly released in the much more damaging future fires described above.

All resource management professionals know—and the Natural Resource Conservation Service, National Park Service, Forest Service and Bureau of Land Management acknowledge—that the loss of the grass-forb "herbaceous layer" means vast increases in bare ground, high, bare-ground soil temperatures between woody plants, much-increased erosion, rapid surface (runoff) and subsurface losses of soil moisture and terrible losses of critical biological potentials.

What some may not understand is this: "Soil Degradation in Place" also occurs. Simultaneous to the usual accelerated erosion common to bare ground between shrubs and trees; soil bacterial-consumption-caused losses of soil carbon continue in upper soil layers.

The Park Service has undertaken some much-needed restoration efforts, even in Bandelier Wilderness and elsewhere. They removed most small-diameter trees and scattered the saw-slash to intercept sheet and rill flows of water on this degraded pinyon/juniper woodland—thus reestablishing the remnant herbaceous layer and restoring this sequestration pathway. Such efforts should be undertaken West-wide. The opportunity exists to use scientifically supplemented (nutrient supplements) goats to accomplish these treatments. Within a NEPA or NEPA-like protection framework, suitable sites could be opened to (closely controlled) commercial goat operators, which should pay no grazing fees while providing such a valuable ecological service. Biomass burning electro-generation and other stand thinning opportunities also have been proven worldwide.

Present Federal policy as practiced tends to actively prevent what we are proposing today. Our proposed grazing strategies, for example, protect streamside riparian values and the health of uplands as a matter of their standard course. They make many standards and guidelines obsolete and destructive of the overall resource.

During the last 30 years, it has increasingly become a career risk for Federal employees to support such efforts or recognize scientific facts. Any land-related policy from any organization which ignores basic biological facts in favor of political or other philosophy is fatally flawed and therefore destructive in its first principles. This "Blind Rage Against Livestock"—or against any human activity—has led to an atmosphere where blatant falsehoods are spread by Federal staff in NEPA and other documents.

There are far too many instances to share here, but Federal scientists have claimed, for example, that cows eat several endangered fish species and their endangered fish eggs, step on the nests (redds) of endangered fish species that in fact do not make redds, claimed that dry washes were critical habitat for several endangered fish species, etc., etc.—all to hurt ranchers. The public, media and some environmental groups and by ignorant precedent, the courts, have inherited a belief that simply "leaving such areas alone" will lead to ecological recovery.

This is a false, vain hope—and all competent professionals know it. Our proposals are based on the most basic, elemental matters of land management. Only the role of these particular fungi in soil carbon sequestration and some microbiology is in any way new knowledge. Having lost the grasses and the ability to retain rainfall without high runoff percentages, the hold the dominant woody species, the abiotic forces and structures like incised erosion patterns have on such places cannot generally be broken without human intervention.

Earl McKinney (retired) and his BLM team, working with ranchers, famously restored perennial flow to a seasonally dry Oregon trout stream that had succumbed to thickening woody populations—in a very brief period. They cut invading Juniper trees and threw them into erosion features and otherwise placed them as sediment traps. The stream soon attracted beavers, and their dams raised soil-water levels—soon restoring lost meadows.

Another laudable intervention practiced on the same principles described here is occurring in Marin County, California which is documented to be effective in soil carbon sequestration. We will hear extensive testimony about it in this hearing. Well-made compost is applied to rangelands grazed by well-managed cattle. This immediately cools the soil and provides nutrients for the soil food web (described in this piece). This can move the process forward by years. I am looking forward to hearing John Wick describe this project and the most recent developments.

As a matter of information, similar work is ongoing at Fort Collins, Colorado, using cost-effective biosolids applications. I have seen the progression on the Fort Collins ranch from xeric Blue Gramma to dry-meadow spacings of far-more-mesic Western Wheatgrass (stems perhaps ⅓″ to ¾″ apart) highly increased photosynthesis and plant biomass levels and a much longer green period, and completely shaded soils due to this treatment. It has also been used to similar experimental effect on the Rio Puerco drainage in New Mexico where native biodiversity and soil stability were also jump-started effectively, according to published reports. This has also been done on a very large scale at Sierra Blanca in west Texas, to similar effect. Doctors Dick and Pat Richardson of UT Austin were on the team monitoring the project. They reported years of positive results to me personally. Outlined by comparative barrenness of the surrounding areas, the green, carbon-storing, biodiverse project area can be actually be seen from space.

For "most resource recovery for the dollar" economic reasons, limiting most ranchers—once range sites have reached degraded, high-bare-ground-percentages—restoration of sequestration potential must proceed from hugely multiplying "microsites". I have seen establishment of multi-thousand acre native dry-country perennial grass stands in a single wet year by this method. Microsites are small locations where water and/or organic matter are able to collect and ameliorate (make life-friendly) the deadly to-seedlings and germination-preventing bare ground conditions. Making microsites works like a light application of compost or biosolids, but is not generally as continuous or as nutrient-laden.

On 105° F., fairly windless summer days—not uncommon in much of the West and Midwest—dark, dry, bare soils can reach 158° F. and more. That's the temperature of well-done roast beef. No seedling can long survive such conditions. No seed will germinate without several days of moist soil.

If created in grazing operations like those advocated here, by far the most cost-effective, easily placed and mass-producible microsites are livestock hoofprints. These, when in sufficient densities, roughen and pit the soil surface and function "riffle-fashion" to interdict the surface flow of water or air carrying the most valuable soil surface elements (like seeds) and force it to drop them. Herds easily break up and block erosion rills, can "round out" other erosion features and establish sediment-trapping grasses in their waterways. Tracks also force large percentages, often all, of moderate precipitation to stay in place in the germination and root zones.

They are very effective seed-catchers. Without them there is little hope of reestablishing grasses, etc. in bare ground.

Significant rainfall events loosen and transport high-quality organics from the edges of leaf-fall deposited at the drip edge of shrubs and trees. I have personally run experiments using a heater and variable-speed fan to simulate a periodic hot, dry wind's effects on native grass seeds in simulated bare-soil cow tracks and on bare, level, crusted soil. Equal amounts of water were applied at the same intervals. Equal amounts of chopped, dry grass and decomposed organics were applied upwind. The tracks retained most of the grass and other organics and caught nearly all of the water. The soil at the bottom of the tracks never dried. The seeds germinated. The grass blew off the flat soil surface. Much of the water ran off—carrying the decomposed organics. The trackless soil dried to the bottom of the deep trays. The seeds did not germinate.

If we are really serious about reducing atmospheric carbon we must find ways to restore the effectiveness of lands which effectively stored soil carbon in pre-settlement days. This certainly can and should include the public lands, some of which because of their degraded and deteriorating condition are actually contributing CO2 to the atmosphere. Thick, unhealthy forests now grow in formerly grassy Native American "Pine Savannahs". They are rooted in soils which science has proven can only be produced under grass cover. On Arizona's Mogollan Rim in the late 1800s, General Crook reported moving cavalry in columns, "many troopers abreast" in grassy pine stands where thousands of trees per acre now shade the soils and exterminate grasses.

The Federal Government has known about the consequences of thickening tree stands since the "Light Burning Controversy" of the late 1800s and early 1900s. Some foresters argued then for retaining Native American forestry methods using frequent cool-season ground fires of low severity to keep fast-growing forest structures open, maintain biodiversity and watershed function, and prevent forest crown fires.

The "Light Burner's" (many of whom were timber-stand owners) lost the policy argument—their ideas scorned as "Paiute Forestry". Those favoring entirely mechanical European-forest-based methodology, using logging and direct thinning as the only management tools, actively prevented use of the centuries-proven Native methods. The forest densities got entirely beyond Government control. The Clinton administration and environmentalist lawsuits effectively ended this period by driving most timber-harvest out of the public forests.

What they failed to realize is that after 100 years of building progressively greater fuel loads—so that there was far more live, standing dead and downed timber, etc. after logging ceased than before it began—their return to primarily fire-based management without transitional fuel load reductions would prove to be a horrendous calamity. Hugely destructive, hugely expensive mega-fires were triggered by exceeding forest-safety thresholds in the wave of enthusiasm. Contrary to the public's (and many Federal staffer's) beliefs, Federal data shows peak flood flows from the *average* Southwestern wildfire to be 2,300 percent + greater than from a CLEARCUT where all trees are removed.

Fuel loads still grow by 11 percent a year. Restoration of the herbaceous soil-sequestration pathway can certainly be greatly accelerated by using a fraction of the Forest Service' budget-dominating fire costs to restore lower Native American-era tree densities in a biodiversity-sensitive, strategic system of treated-forest firebreaks as we restore the natural order. According to the 4–FRI (Four Forest Initiative) studies these efforts will create a net economic return.

Following several megafires threatening to exterminate regional forests, major environmental groups in the Southwest have recognized the error of banishing timber harvest as a tool of management (the Southwest Center for Biodiversity and the Grand Canyon trust among them). They helped create the "4–FRI Plan" in Arizona. In a miracle of common sense and real science, a collaboratively crafted plan to thin 300,000 acres was adopted by the Forest Service. This would by its nature open the herbaceous sequestration pathway as restored, grazable woodland. The environmental groups helped recruit a large industrial investor who would have paid essentially all costs (even millions for scientific monitoring) through proceeds from manufacturing OSB (oriented strand board) from the forests' small-diameter trees.

Clearly, these vigilant, major green groups see this principle as a big "Win" for nature. Unfortunately, the program was co-opted by giving the contract to a far-inferior bid from a weakly financed biofuels operation, whose process, according to the SW Center for Biodiversity, had never worked at industrial scales and had failed miserably elsewhere. I expect that Gila County Supervisor Martin, who was directly involved in this innovative effort, will speak to this and related forest and rangeland sequestration issues. Little thinning has occurred.

After sad losses of ecosystem health and native biodiversity due to past *unmanaged* grazing, the centuries-old concept of using livestock as a restoration tool has been greeted with considerable skepticism. Sadly, too, the skeptics have generally not been competent (or for odd reasons not willing) to draw the very real distinction between managed and unmanaged grazing.

Research has been crafted (we believe for political/fundraising reasons) to challenge the specific principles of grazing advocated here. But, in fact, it's laughable stuff. The researchers refuse to understand reality: ecological restoration can be created most effectively at landscape scales, by the best ranchers, using these best practices, in an adaptive manner that changes to appropriately address changing circumstances. It's not uncommon for these inexperienced and uninformed, largely urban-researchers to create a completely rigid (therefore weather, etc. inappropriate) protocol, then confine an animal or two—which are in distress at their isolation—pacing the perimeters of tiny pastures looking for a way out—and expect such abstract, unscientific shambles to replicate real managed grazing and its effects. A few years ago, Dr. Jerry Holechek and others produced a paper, "Managed grazing versus grazing exclusion: what we have learned," the protocols of which rejected nearly all the anti-livestock activist's typical bibliography for poor study designs and bad data.

Soil Carbon Sequestration, Endangered Species and General Biodiversity: It is vain to suppose that most endangered species can ever be truly recovered without restoration of pre-contact soil carbon levels. High-carbon soils are self-replenishing reservoirs of stored potential energy, water and nutrients. By the Law of the Minimum, populations are limited by the energy available to them, especially at critical times. Example: if sufficient water to digest food and meet metabolic requirements is lacking, no amount of forage, however large, which lacks the necessary water, is actually available. Further, no amount of water, however large, is actually available to a Sage Grouse if a hungry coyote, fox, or hawk won't let them have it.

Noted bird expert Mark Stackhouse discussed Sage Grouse survival this way: In badly degraded ecosystems, the grouse must simply leave. If better habitat is not found, they die out. Why? Because, in poor habitat the distance between survival requirements is too great to justify the energy gained by the energy expended, in relationship to the risk posed by predators. Jackrabbits and some other prey items have lower-quality year-round forage requirements than do grouse—so while Jackrabbit populations continue—the grouse are exposed to higher predator numbers supported by the rabbits, etc.

Spring-hatched Sage Grouse chicks don't get milk. They require high-protein and high-energy, low-toxicity, fairly succulent plant material and abundant insects—and free water, in addition to escape cover and maternal attention (the species also need contiguous habitat options to maintain genetic diversity—like vast, over-lapping grazing lawns). The longer the distance between required items, the more total energy, etc. they need, and the more their high movement level and long scent trail will attract lethal attention.

Healthy, high-organic matter soils (as in continuous grazing lawns) mean much longer green periods, meadows, springs, plant and insect biodiversity and habitat health—which mean short travel distances at any age—so, higher survival. They also mean more eggs per mother, more chicks, and higher brood survival. The numbers back this up. Sage Grouse don't just need sagebrush (their main winter staple food) they need productive Sagebrush Steppe ecosystems.

The Utah ranch on which Stackhouse hosts birding tour has been designated as a World Wide Important Bird Area by Audubon—with over 300 bird species and a big percentage of the state's Sage Grouse. High species richness of birds is common to ranches managed in our proposed manner.

In my judgment, if any species is in danger in the West, the key to its recovery is, with high probability, found in rectifying the key relationships (so, higher soil carbon) described as leading to sustainable biodiversity in this testimony—not in simply protecting them from human activity.

Southwest Willow Flycatchers (SWF) are another example. Most western biologists know that around half of this subspecies lives on or surrounding a single ranch in the Gila-Cliff valley of New Mexico. The ranch is managed by the principles discussed here. Though the Federal Government maintains reserves containing the willows and gallery forest they believe the birds need—they were mainly unoccupied at my last information.

Studies find that the ranch Flycatchers nest in certain branch configurations of Box Elder trees. They eat mostly bees. Why? Likely because well-managed, healthy meadows contain pollinating grasses and flowers, especially legumes with abundant blossoms. The use of bees (rather than flies) is easy to understand from an available energy standpoint: bees are bigger than flies, concentrate toward a certain location, and there are lots of them there.

The greatest threat to SWFs is identified as Cowbird parasitism (and by association, cows)—wherein Cowbirds chuck the SWF's eggs out of their nests, lay their own, and the SWFs raise their young for them. But, the ranch has the lowest level of Cowbird parasitism on record—despite high Cowbird numbers. Why? There is an available energy/soil richness explanation. It could be that when things are good—Cowbirds don't need to parasitize as much (there are lots of healthy cows to pick insects from and around). The ranch and valley are also the home of the highest and most species-diverse population of non-colonial riparian birds anywhere in North America—including endangered birds other than SWFs. There are also high numbers of upland species. Maybe massive bird numbers just spread the Cowbirds thinner.

The highest parasitism rate of Cowbirds on SWFs is in the Grand Canyon—where there are no cows. Though the fly, etc. numbers for SWFs are good next to the Colorado River—the upland available energy for non-riparian bird species is poor—as is the soil.

Management for soil carbon has tremendous implications for water dynamics, as we have said. Gabe Brown's ranch (same management principles) in North Dakota is documented by Federal scientists (world-class sequestration researchers) to have recently absorbed a 13 inch, 24-hour rain event with no erosion and no runoff. Gabe has tripled his soil carbon in a few years. The neighbor's land was still waterlogged and partly under water 14 days later. It's reasonable to state that if all land in the Missouri Drainage and associated rivers was managed like Gabe's, the floods in this system would be greatly curtailed and the water stored in vast, regional soil reservoirs for steady release. Using these methods (including woody-species information, above), perennial stream flows have frequently been restored.

Waterfowl successfully raise up to 3 broods on never-dying potholes on Gabe's friend Gene Goven's Ranch and cropland at Turtle Lake in the water-fowl-critical Prairie Pothole area of North Dakota (same management principles). Most potholes dry up in summer. The birds struggle to raise one clutch. Gene's soils have much-elevated soil carbon due to grazing by our adaptive prescription. He documented a 6 inch rain with no runoff. The water entered the soil and started only raising the pothole levels a week later. Almost all species benefit from continual water availability. Ducks Unlimited of Canada subsidizes young rancher's education if they'll imitate Gene, Gabe and the others.

Also, Tallgrass Prairie species (Big Bluestem, etc.—no seeds planted—usually found far east of Gene in much higher precipitation) on what normally would be dry, blue Gramma etc.-occupied glacial-till hilltops on this ranch years ago. Short Blue Gramma to Tall Bluestem. Big jump. Frogs hunt insects on those hilltops now—a thing normally unheard-of.

Prescribed grazing on these principles started replacing non-native grasses and thistles on the Audubon National Wildlife Refuge within 2 years of Craig Hultberg's management changes. Prior to this, most of the job was spraying toxic defoliants.

In summary, Mr. Chairman, I hope it is clear that we know how to sequester vast amounts of CO2 in the soils of the public's grazing lands and forests. This is not a theoretical claim. It has and is being done on millions of acres around the world even as we speak. And by taking the steps to sequester carbon on these lands, all of the other economic and environmental benefits will follow as a result of natural laws.

There really is no downside to this approach and many, many upsides. It truly is not just "win/win" but win/win/win/win/win/win and so on.

We also recognize that as a policy matter, adopting this approach beyond in areas outside the public lands has major potential positive ramifications. While outside the scope of this hearing, if the controversial and divisive CO2/climate change issue were dealt with in this way, other potential benefits to the economy would follow. It could end the "war on coal." It could allow us to depend more on domestic resources such as coal and export more natural gas to Europe, reducing their dependence on unreliable sources. It could avoid the costs and potential economic dislocations that many fear will follow from the regulatory approach the Obama administration is pursuing.

But, let me also stress that to achieve these benefits on the public lands, and therefore put the United States in a position to demonstrate the value and potential of soil sequestration on landscape scales, will require the Congress to act. It will require changes in the Federal management approach that, as we have pointed out, is currently not only preventing enhanced carbon sequestration but also preventing the wise and responsible management of all of the public's lands and resources.

QUESTIONS SUBMITTED FOR THE RECORD TO STEVEN RICH

Question 1. You have said that you believe that the Federal Government's worldwide annual carbon footprint could be sequestered on the public lands and forests. Can you provide more details to support this assertion?

Answer. It is entirely possible to sequester the Federal Government's total carbon footprint on the Federal lands.

This can be easily shown by looking at the total Federal carbon footprint, the amount of Federal lands available for sequestering carbon and estimates of the rates of sequestration for various types of land. This simple analysis recognizes that these lands in most cases are already sequestering carbon in soils. So, to sequester the Federal carbon footprint requires sequestering additional carbon beyond what is already occurring. That would be accomplished largely by use of specific livestock grazing methods targeted to increase rangeland quality, and through proper forest management practices, primarily thinning, to improve forest health, enhance the growth of remaining trees and create a grazable understory that can also accelerate carbon soil sequestration.

This analysis does not try to include how much of the CO_2 emissions now being contributed by these lands, largely because their poor condition or increased risk of wildland fires, would be prevented by these proposed measures. But it should be recognized that the same management techniques that will increase carbon sequestration would also reduce these emissions in the future.

According to an analysis of total Federal carbon emissions coordinated by the Council on Environmental Quality, the Federal carbon footprint in 2010 was about 123 million metric tons of CO_2. The Federal Government claims that in subsequent years that footprint has been reduced somewhat but hard numbers are difficult to come by. However, an estimate of no more than 120 million tons for 2014 would seem to be a conservative estimate.

There are several types of Federal lands in which additional carbon could be sequestered, often with only slight changes in the current management of these lands. The easiest lands on which these management changes could be made are those currently being actively managed for multiple uses, primarily lands managed by the Bureau of Land Management and the Forest Service.

The BLM administers 245 million acres of land and manages grazing permits on about 150 million acres of that total. The Forest Service administers about 193 million acres of forests, with grazing occurring on about 90 million acres. This includes about 4 million acres of National Grasslands which are managed almost entirely for grazing.

These multiple use managed grazing lands amount to about 240 million acres in total. Changes in grazing management can potentially provide large and rapid increases in carbon sequestration depending on such factors as precipitation and length of growing season. Each of these 240 million acres of BLM and Forest Service grazing land would only have to sequester an additional half ton of CO_2 per year on average to completely sequester the entire Federal carbon footprint. Because better grazing management of private lands that are similar to much of the public lands can sequester an additional ton of CO_2 or more per acre per year, sequestering just half that amount on average on these 240 million acres would be a reasonable goal.

In addition to these multiple use lands, other Federal agencies manage lands that could also be used to sequester the Federal carbon footprint. There are at least 4 million acres on National Wildlife Refuges in which targeted grazing could be practiced. The Department of Defense administers about 28 million acres of land, including 16 million acres withdrawn from formerly BLM administered land. While not all this land could be managed to increase carbon soil sequestration because doing so might conflict with the primary purpose of the refuge or defense facility, much of it could be used to do so.

In addition to this land the Forest Service and BLM administer tens of millions of acres of forests. Better forest management practices can result in additional carbon sequestration on the order of at least 1 to 2 tons of CO_2 per acre per year. This means that only about 60 million acres of forests that are being better managed to sequester atmospheric carbon could by themselves potentially sequester the entire Federal carbon footprint. In doing so, a number of other benefits would also accrue. The primary one as far as atmospheric CO_2 loading is concerned would be greatly reduced risk of wildfire.

Combining all of the Federal lands that could act as sinks for the Federal Government's carbon footprint makes it clear that sequestering it on the Federal lands could certainly be done.

Question 2. You were challenged on your assertion that grasslands and related ecosystems store the most carbon with the greatest security but were not allowed to reply. How would you answer that question more completely?

Answer. It is perhaps a matter of classification. My statement included a composite of totals from ecosystem types containing a large grassland component: Temperate Grasslands, Savannahs and Grass/Shrublands clearly fit this category, as do Tropical and Subtropical Grasslands and Savannahs. Tundra also has a strong grass and herb component as does a fair amount of Boreal Forest (much more when Boreal Forests burn—which many millions of acres do every year). Temperate Forests—depending on tree density—also contain vast grass/forb acreages between trees. When much lower-than-present Native American produced tree densities are restored these forests can sequester far more in the synergic relationship between grasses, forbs, trees, shrubs and soil organisms. Any of the witnesses would probably agree that Deserts and Dry Shrublands (as mapped in the U.N. etc. report—link, below) are also capable of producing significant grass/forb biomass and storing large composite amounts of soil carbon through the "liquid carbon pathway symbiosis."

Under this system of classification my assertion was certainly correct.

Source: UNEP (United Nations Environmental Program), the WCMC (World Conservation Monitoring Center) and the German Federal Ministry for Environment, Nature Conservation and nuclear Safety, German Federal Agency for Nature Conservation

LINK: http://www.carbon-biodiversity.net/Issues/CarbonStorage

Question 3. In your statement you were critical of claims made in Federal NEPA documents related to protecting or recovering some threatened or endangered fish species that cows eating these fish was a threat. Can you provide more specifics and background for this statement?

Answer. In my 30-year career as a Resource Management consultant I continually dealt with false claims such as this one. The U.S. Fish and Wildlife Service made the claim in several Biological Opinions from Tonto and Coronado National Forests, through biologists Jerry and Sally Stefferud , based on a study of the effects of human fishermen trampling in streams—DESPITE the fact that it says NOTHING AT ALL about cows eating fish, or any references whatever to cattle or the cyprinid species in question (Loach Minnows, Gila Topminnows, Gila Chubs, etc.). In other cases the agency claimed that seasonal flood channels were critical habitat for Lahontan Cutthroat Trout.

Citation: Roberts, B.C., and R.G. White. 1992. "*Effects of angler wading on survival of trout eggs and pre-emergent fry.*" North American J. of Fisheries Management 12:450–459.

I include the abstract of the above study:

Abstract

> The effects of angler wading on trout eggs and pre-emergent fry in artificial redds depended on wading frequency and stage of egg or fry development and was similar for brown trout *Salmo trutta*, rainbow trout *Oncorhynchus mykiss*, and cutthroat trout *O. clarki*. Twice-daily wading throughout development killed up to 96% of eggs and pre-emergent fry. A single wading just before hatching killed up to 43%. Wading killed fewest eggs between fertilization and the start of chorion softening (except for a short period during blastopore closure when mortality increased slightly). It killed the most eggs or fry from the time of chorion softening to the start of emergence from the gravel. Restriction of wading could be an effective management tool if trout spawning habitat is limiting and angler use is high during egg development.

Tonto National Forest biological Opinion: Page 12—"*Livestock may directly affect fish through trampling (Roberts and White 1992) or ingestion of adults, larvae, or eggs. Trampling of adult fish is probably rare, except in localized situations, or with smaller fish such as Gila topminnow.*"

https://www.google.com/
?gws_rd=ssl#q=cattle+ingest+larvae+and+fish+eggs+stefferud&safe=active

BIOLOGICAL OPINION

On-going and Long-term Grazing on the Tonto National Forest
Arizona Ecological Services Field Office
U.S. Fish and Wildlife Service

AESO/SE 2–21–99–F–300
February 28, 2002

The USFWS knew the Stefferuds' claims were bogus: (same document) "Rinne (1999) points out the problems associated with many of the studies that show the possible impacts of livestock grazing to riparian and aquatic habitats and fishes. However, these studies represent the best available information on the subject.": (Roberts and White 1992)

This stock phrase is used in four documents:

Memorandum
To: ARD-Federal Aid, Fish and Wildlife Service, Albuquerque, New Mexico
From: Field Supervisor
Subject: Section 7 Consultation for Reintroduction of Gila Trout into Arizona
Page 9—"Direct effects from livestock grazing are trampling or ***ingestion*** *of adults, larvae, or eggs (Roberts and White 1992)"*

When we challenged them on the absurdity of cows eating fish and that cattle cannot trample the nests (redds) of cyprinid fishes that do not make redds, USFW backed off to this statement (below) in the final draft of only the Coronado BO (below). Note, again, that Roberts and White 1992 says nothing about *cattle* trampling anything. It is a discussion of human angler's trampling. Nevertheless, the idea of fishes (or frogs) waiting around to be trampled is highly unlikely. Please note also that all the cyprinid fish species in question spawn only when streams are muddy due to flooding. It is highly unlikely that their eggs are damaged by silt as are trout eggs.

FINAL BIOLOGICAL OPINION and CONFERENCE OPINION

Continuation of Livestock Grazing on the Coronado National Forest

Arizona Ecological Services Field Office
U.S. Fish and Wildlife Service
AESO/SE 2–21–98–F–399R1
October 25, 2002

Page 16— *"Livestock may directly affect fish through trampling of adults, larvae, or eggs (Roberts and White1992); likely the same holds true for frogs. Actual trampling of adult frogs or fish is probably rare, except in localized situations, or with smaller fish such as Gila topminnow."*

The libeled Ranch owners (Jim and Sue Chilton and family) against which the baseless Coronado Chub, etc. claims were filed by the South West Center for Biodiversity (CBD) etc., sued for relief in the 9th Circuit Court of Appeals. The Court awarded $600,000 in damages and declared the FWS Biological Opinion for the Chilton's Montana Allotment "arbitrary, capricious and unlawful." The court also ruled that CBD had acted with ". . . an evil mind."

http://www.chiltonranch.com/images/got-cha.pdf

Question 4. Mr. Rich, you stated your opinion that it's useless to attempt sustainable recovery of most endangered species without restoring pre-European-contact soil carbon levels. Why is that?

Answer. That's because, as we all testified, high soil carbon supports life in so many ways and keeps death at bay under what would certainly be lethal circumstances with badly depleted and degraded soils.

For instance, the drastic, unsustainable declines in Yellowstone National Park elk numbers can't be explained by the mere presence of wolves. Researchers vary in their explanations, but the "life-supporting" role of overall "high available energy" stocks in high-organic-matter soils (thus producing better soil, plant, and animal nutrition, water availability, drought tolerance, etc.) and their clear role in supporting the resistance of organisms to disease, their ability to reproduce, their resilience as individuals and as populations to predation, drought, etc. cannot be over-emphasized.

Dr. Rod Heitschmidt (now past President of the Society for Range Management) some years ago sent an official rebuke to the National Park Service concerning the condition of Yellowstone Park—particularly the northern area. He described that area as degraded beyond recovery thresholds achievable in less than geological time frames due to entrenched, braided stream channels, widespread soil erosion and many other factors affecting soil and plant health, hydrological function, etc. He also said the Park Service had a long, philosophically motivated history of deliberate misinformation concerning the health of the Park's ecology as a result of decades of overgrazing by unrestricted elk, and bison (to some degree). Heitschmidt also said the ecological condition of the park compared unfavorably with nearby ranches.

The re-introduction of wolves was supposed to fix all these problems by controlling elk numbers. Indeed, willows, aspens and berry-producing shrubs have rebounded somewhat with sharp-eyed wolves to guard them. But nutrition levels are still insufficient for elk. So—the park's elk populations have nose-dived toward oblivion. Understand—bears kill more elk in Yellowstone than do wolves. But before wolf re-introduction—living with lots of bears—elk are said to have spent far more time in their favored grasslands. Then, they spent more time hiding in forests. Wolves see much better than do bears. Apparently the elk know that. This behavior change in elk had nutritional consequences. A 2009 study by Scott Creel and others (who made the above observations) said elk get 27 percent less food intake from sparser forages from woody species found in forests—where bears wait in ambush. A newer study by Middleton and others (2013) finds that the elk have adapted, and now tend to stay in grasslands and deal with wolves.

If Native American-Era wider tree spacings were still present, there would be plenty of grass in the forests and the sharp-eyed elk could also better see the bears coming. Recent research reveals elk calf 1 year survival rates as low as 11 percent to 15 percent. This is unsustainable. Normal annual pregnancy rates for elk in the West average around 90 percent. Pregnancy rates (tied primarily to nutrition) for migratory Yellowstone elk ranged from 59 percent to 70 percent—far too low maintain a healthy population. A U.S. Dept. of Interior/University of Wyoming/Wyoming Game and Fish Department news release (link below) also quoting Yale researcher Arthur Middleton reports that "Though elk typically bear a calf every year, migratory elk that nursed a calf had only a 23 percent chance of becoming pregnant again in the following year." The study further states that "Migratory [Yellowstone] elk experienced a 19 percent depression in rates of pregnancy over the 4 years of the study and a 70 percent decline in calf production over 21 years of monitoring by the WGFD."

The median age of elk populations in the Yellowstone area is now rising steadily toward sterile senility. Reproduction rates and survival of young are very inadequate. There is a general consensus that the sub-population-survival "recruitment" rates of young elk have their cause in low nutrition in both females and young. Well-fed, mobile elk with solid habitat options (so they don't have to stay and get extinguished) can handle predation. A combination of healing erosion features and higher soil organic carbon is proven to greatly increase forage quality and production during dry periods. This would solve the problem.

I would add that outside the parks, conflicts with wolves and humans are to a large degree conflicts for scarce resources made scarce by bad policy. Many wolves have now left the park due to diminished prey resources. This stubborn clinging to political tradition in range and forestry issues while ignoring feedback from real world conditions has consequences for every plant and animal species of concern of which I am aware. Certainly, hunters would be more tolerant of wolves if the often 1,000 percent gap in forage production between lands managed in the manner we suggest were closed by allowing proper management on Federal lands. This means using livestock as a restoration tool benefiting all phases of forage plants' life cycles. Dr. Teague gave a detailed description of the principles in his presentation.

This would certainly allow elk, Mule Deer, etc. populations—which are now nutrition-limited during some seasons in much of their range—to expand. Certainly, ranchers would be much more tolerant of wolves, elk, etc. if they and their herds were not on the edge of extinction themselves due to woody species encroachment, forage limitations in droughts, etc.

The film, "Never Cry Wolf" describes Alaskan wolves (no livestock present) switching to alternate prey species (mice in that case) when favored prey are not available. There are obvious implications for Sage Grouse, Utah Prairie Dogs, White-tailed Prairie dogs, Black-tailed Prairie Dogs, Pygmy Rabbits, certain species of Kangaroo Rats, etc., etc., just with respect to wolves. Think of wolves competing with hawks and eagles (all raptors are species of concern) for ESA-protected rodents, Sage Grouse, Mule Deer (another species of concern). Yes, eagles do kill mule deer. Many other species will be affected. But, we start to get the picture why soil carbon levels are critical to endangered species reintroduction and conservation.

It also should be noted that wolf pups do and/or will in future hunt ESA-protected rodents, reptiles, etc. as part of their juvenile prey base—for hunting skills practice—and to consume them. This "practice hunting" happens continually—in every pack—whether the adults seek smaller animals as prey or not. "The low-energy, low carbon soil affecting all species survival problem" comes full circle when we see species of concern dining on other endangered species (as with wolf pups).

Another example of degraded habitats affecting remnant populations of all species is where rare river otters (Lontra Canadensis) in NE Nevada's Mary's River (Humboldt tributary) frequently eating rare Lahontan Cutthroat Trout. They are surrounded by once-perennial streams that were once habitat for much larger populations of both species. The unwillingness of the management agencies (either on philosophical grounds or due to lawsuits) to manage woody species and employ livestock in restorative configurations cascades into every species' survival chances.

Many native grasses get out-competed by invasive species because, compared to the exotic species, they have poor germination and seedling establishment rates. That only makes sense if these native species are actually adapted to higher soil carbon levels. In general, in my experience, all native plant species in the West can out-compete exotics in their native soil carbon levels. The mycorrhizae, etc. are better-adapted to natives and favor them if they can act as healthy hosts. My written statement contains examples of this phenomenon from Arizona to North Dakota, to Missouri and Virginia. The fact that over 300 bird species are attracted to Deseret Ranch further illustrates this point. (This phenomenon is now said to affect bird migration patterns well into Central America and perhaps beyond.)

Since all the ecological, community financial and sociological benefits described by all four witnesses at the hearing are generated by profitable operations—as they have at Deseret Ranch and our many other examples—it seems both wise and beneficial to adopt the same profound and scientifically based principles on public lands. If the Nation can get behind this project—think of the politically and sociologically unifying effects that will create. These principles conform to the larger pattern on which both peace and prosperity have their foundations. We must not miss this chance to come together in what is clearly a noble and necessary cause.

NUTRITIONAL CONDITION OF NORTHERN YELLOWSTONE ELK
Journal of Mammalogy, 85(4):714–722, 2004 RACHEL C. COOK,* JOHN G. COOK, AND L. DAVID MECH

"Elk Calf Survival and Mortality Following Wolf Restoration to Yellowstone National Park" Wildlife Monographs #169 (May 2008); published by The Wildlife Society, SHANNON M. BARBER-MEYER,1,2 L. DAVID MECH, P.J. WHITE

Cause-specific Mortality of Rocky Mountain Elk Calves in Westcentral Montana

Nyeema C. Harris; Daniel H. Pletscher; Mike Thompson Montana; Transactions of the 72nd North American Wildlife and Natural Resources Conference v 343

"Northern Yellowstone elk population continues to drop"

http://trib.com/lifestyles/recreation/northern-yellowstone-elk-population-continues-to-drop/article_1baec009-60ef-5fb0-9f99-e37b905150c4.html

"Linking anti-predator behaviour to prey demography reveals limited risk effects of an actively hunting large carnivore" Arthur D. Middleton,1,2,10* et, al.; Ecology Letters, (2013) doi: 10.1111/ele.12133

http://klamathconservation.org/docs/blogdocs/Middletonetal2013b.pdf

Migration No Longer Best Strategy for Yellowstone Elk

Released: 6/5/2013 U.S. Department of the Interior, U.S. Geological Survey

http://www.usgs.gov/newsroom/article.asp?ID=3611&from=rss#.VVoK1vlViko

Question 5. You spoke about the advantages of creating "grazable woodlands" as efficient carbon sinks that are also more resistant to catastrophic fire. Can you explain briefly how currently unhealthy forests on public land that are at high risk for wildfire could be converted to grazable woodlands? Are you aware of any examples of where this has been done successfully on national forests?

Answer. Almost all public land forests have natural "alternate state vegetation" which follows fires, blow-downs, lethal insect infestations, etc. Aspen/grassland communities and Gambel Oak/grassland communities are examples. These disturbance events (fires, etc.), releasing herbaceous understories, create "grazable woodland" sites. These have always attracted ungulates like deer and elk. Targeted livestock use can accelerate these sites healing and prevent erosion by trampling and interdicting rills and other water channels which form on disturbed soils.

The advent of mega-fires with high proportions of severely burned lands begs for effective treatments. Targeted grazing has demonstrated its success on mine sites and private burned woodlands. Fifty percent of severely burned forests no longer produce trees (Savage and Mast 2005 in Wu, Kim and Hurteau 2011 cited below). This type of realization must guide decisionmaking at all policy levels regarding carbon sequestration. When we can "no longer see public land forests for the trees"—there are too many trees.

Optimally reducing tree densities in unhealthy, mega-fire prone forests restores the abundant grass-based soil carbon sequestration pathway—while preserving now-faster-growing, much larger tree's stocks of carbon and relocating cut stocks into buildings. This practice is properly considered to be ecological restoration. The authors cited here use this terminology, as does the journal, "Restoration Ecology" (Wu, T.*, Y-S. Kim, M.D. Hurteau. 2011 "Cutting trees to save forests: using economic incentives to overcome barriers to forest restoration." Restoration Ecology, 19:441–445).

These "restoration thinning treatments" often focus on removing primarily small-diameter trees. This both protects larger trees from fire and increases their growth rate (tissue sequestration) in addition to greatly increasing their nut production—which, is critical to many bird and rodent species—even in conifers with very small, economically non-harvestable seed sizes. It also allows much more sunlight to reach soli surfaces in what are, in the West, the higher rainfall areas—stimulating often huge increases in grass and forb growth, thus, further greatly increasing soil carbon sequestration. Grass/forb increases of 1,100 percent and more and large jumps in species diversity have been recorded.

By its nature, restoration thinning re-creates grazable woodland and accelerated carbon sequestration in the grass/fungus-created, high-carbon molisols (soils) in which southwestern tall conifer forests typically grow. The experiential, shared collaborative process that created the Four Forests Initiative (4FRI) in Arizona caused stakeholders, even, notably, the Grand Canyon Trust and Center for Biodiversity, to see that allowing such huge small-tree stem densities to continue in southwestern forests constitutes environmental malpractice. Gila County will submit a documented account of this collaborative process.

I have included this report: "Management Guidelines for Expanding Pinyon Nut Production in Colorado's Pinyon-Juniper Woodlands" prepared by: Rebecca J. McLain and Penny Frazier.

http://www.ifcae.org/publications/downloads/PJE_Mgmt_Guidelines_03-18-08.pdf

I have done so because the restoration thinning process for grazable pinyon/juniper woodlands mirrors in most ways the practices for vastly increasing pinyon-nut production. Example, ". . . *domesticated livestock and their manure in pinyon-juniper woodlands positively affects pinyon cone production. Evidence from Africa indicates that domesticated livestock can play an important role in fertilizing trees and crops in semi-arid environments*" (McClain, above).

According to sources cited in the report, "*These short, twisted trees with large branching crowns live in association with more than 1000 species of microbes, plants, insects, birds, and mammals.*" Nut production likely benefits all of them directly or indirectly. Concentrated, short-term goat grazing is used as a primary thinning method in pinyon/juniper woodland. It has the advantage of being able to generate considerable revenue from goat production.

In projects I have designed, I have witnessed positive results like those described for mechanical thinning in this report. These improvements in all biological indicators resulted from grazing by 2,000 close-confined goats in once-terribly fire prone and degraded pinyon/juniper woodland near Payson, Arizona. The goats were protected by herd dogs and herders and were kept from grazing non-target areas by mobile fence panels, the rear parts of which were taken down and reassembled in front of the closely planned herd movement.

The goats removed the foliage from lower limbs (which eliminates the "ladder fuels" which quickly produce devastating crown fires and also acts against disease, parasite and insect infestation). They defoliated and killed small trees, redistributed duff layers (increasing water to roots and increasing fertilizer effects and grass/forb restoration), greatly accelerated nutrient cycling, provided seedling microsites and interdicted erosion rills.

Grazing periods averaged 5 to 10 days. A decade-older treatment exists on the Diamond Rim Northeast of Payson on which herbaceous restoration persists. It should be noted that the enhanced soil nutrition (See McNaughton's "Grazing Lawns." Citation and link below) and its small size has made it a concentration area for wildlife grazers. The fact that the vegetation persists is evidence of how well the treatment worked.

Goats do best on a varied-species diet. The cost of supplementing goats' needs with protein and minerals increases in these woodlands as the trees' health and the degraded sites' species diversity declines. Goat operators may not be willing to use these sites voluntarily if other options exist. It may be that some subsidy for nutritional supplementation might be necessary if such lands are selected for treatment. It is still likely that the cost would be less than for mechanical thinning.

Responses to burning treatments vary greatly—depend on several variables. Some are biological disasters, due to the sites' degraded, low carbon, low soil biodiversity soil condition. Managers should not expect native perennial grasses not already present in the burned area, for example, to colonize these sites quickly. The goal would be to burn individual trees or small patches while avoiding a stand-replacing fire. Such large fires are generally accompanied by serious flooding and soil loss—and which would simply convert the woodland to grassland of highly variable quality—or to bare ground and invasive, often non-native annuals and biennials—with the loss of woodland values and biodiversity.

I have included links for papers concerning management of these woodlands.

Collapse of Pinion/Juniper Woodland biodiversity in Bandelier Wilderness—thinning is effective restoration.

https://www.fort.usgs.gov/publication/21175

Closed canopy P/J causes biodiversity loss—better to manage for "Mid-seral" states

http://oregonstate.edu/dept/eoarc/sites/default/files/publication/588.pdf

http://cpluhna.nau.edu/Biota/pinyon-juniper.htm

Santa Fe National Forest recommendation for treatment of P/J

http://www.fs.fed.us/rm/pubs/rmrs_p009/rmrs_p009_311_314.pdf

Zion Nat'l Park—recommendation for P/J management treatments
PINYON-JUNIPER WOODLANDS IN ZION NATIONAL PARK, UTAH
Kimball T. Harper!, Stewart C. Sanderson2, and E. Durant McArthur2,3

http://www.treesearch.fs.fed.us/pubs/39535

"To enhance plant and animal biodiversity, we recommend that pinyon-juniper woodlands of Zion National Park be managed so that late seral stages do not dominate large tracts."

Grazing Lawns: S. J. McNaughton
Grazing Lawns: Animals in herds, Plant form and coevolution.
Volume 124 number 6, The American Naturalist, December 1984

http://www.jstor.org/discover/10.2307/
2461305?uid=3739928&uid=2&uid=4&uid=3739256&sid=21106453792161

Mr. BISHOP. Thank you very much.
Dr. Teague.

STATEMENT OF RICHARD TEAGUE, TEXAS AGRILIFE RESEARCH, VERNON, TEXAS

Dr. TEAGUE. Mr. Chairman, Ranking Member Grijalva, members of the committee, I appreciate the opportunity to appear today to provide my perspective on increasing soil carbon sequestration on the public lands.

My name is Richard Teague, and I am a research professor with Texas A&M AgriLife Research. I was raised on a farm community in Zimbabwe, and attended university in South Africa. For more than 40 years, I have been a research scientist working on the management of rangelands.

In the course of my research and investigations, I have visited most of the grazing areas of the world. Wherever I travel, I actively seek out the leading conservation ranches to learn what they are doing that makes them so successful. Based on my research and experiences, I can confidently state that large quantities of carbon could be sequestered in a stable form in the soils of the public lands. Doing so would produce a number of important benefits, as carbon is essential to establishing and maintaining soil health, the foundation of a healthy, functioning ecosystem.

Healthy ecosystems produce a range of economic and environmental benefits. There is immense potential to sequester atmospheric carbon in the soils of the world's rangelands through better management. In a chapter that I and several colleagues have written in the soon-to-be-published book, "Geotherapy," we calculate that, with improvements in management in a few decades, global grazing lands could remove the amount of carbon released into the atmosphere by human activity from the Industrial Revolution, around 1750, to the present time. This is a low-tech, low-cost approach that would also generate important economic and environmental benefits.

By demonstrating improved carbon soil sequestration on the public lands, the United States could set an important example to the rest of the world.

The key to generating these benefits is re-establishing the evolutionary grazer-grass relationship. I have three figures, Mr. Chairman, that illustrate how this has been achieved on managed grazing lands.

Figure 1 illustrates the non-uniform impact of continuous grazing over a ranch landscape. The green dots are GPS locations of colored cows over a year of grazing. Plants in the heavily frequented areas are overgrazed, causing poor plant productivity and increasing bare ground, with consequent elevated carbon lost to the atmosphere, increased water runoff and erosion, and decreased carbon sequestration into the soil.

Figure 2 indicates how multi-paddock grazing can facilitate better ecological condition and soil health. All animals graze in a single paddock for a short period before grazing the following paddocks in turn. By spreading the grazing over the whole landscape, animals select a wider variety of plants. Each paddock is afforded sufficient time of recovery before being grazed again. This allows the manager to regulate how heavily each paddock is grazed, and ensures each paddock has recovered before being regrazed. Done correctly, this increases soil carbon and reverses the degradation, as bare ground is reduced and plant growth is increased.

Figure 3 illustrates how previous small-scale research plots misrepresent continuous grazing impacts on ranch landscapes. The smaller areas in yellow imposed on the landscape represent small plot research areas commonly used to determine what impacts the grazing animals are making. Clearly, none of them represents the impacts being made in the ranch scale paddock. This has resulted in research projects underestimating the impact of continuous grazing in large, commercial-scale ranches.

In summary, Mr. Chairman, the adoption of regenerative conservation grazing management can increase the amount of soil carbon in public lands. The key to doing so is actively managing to reduce spare ground, and to promote the most beneficial and productive plants by grazing moderately over the whole landscape, and providing adequate recovery to grazed plants. The goal of improving soil health using regenerative multi-paddock grazing is a high priority.

The written statement I have submitted explains all of this in more detail, and I look forward to answering any questions. Thank you.

[The prepared statement of Dr. Teague follows:]

PREPARED STATEMENT OF DR. W. RICHARD TEAGUE, TEXAS A&M AGRILIFE RESEARCH

Good afternoon. Thank you Chairman Bishop, Ranking Member Grijalva, and all of the members of this subcommittee for the chance to speak with you today. I am Richard Teague, Associate Resident Director of Texas A&M AgriLife Research in Vernon, Texas. I am also a Professor in the Department of Ecosystem Science and Management at Texas A&M University and Senior Scientist of the Texas A&M Norman Borlaug Institute for International Agriculture. I am honored to speak with you today about the important issue of increasing carbon sequestration on public lands.

BACKGROUND AND EXPERIENCE

I was raised in a farm community and schooled in Zimbabwe before obtaining a BSc (Agriculture) in grassland science (1972) at Natal University in Pietermaritzburg, South Africa, and a PhD in botany and microbiology (1987) at the University of the Witwatersrand in Johannesburg, South Africa. As a research scientist working on the management of rangelands since 1972, I have visited most grazing areas of the world, attending conferences and presenting the results of my research. I actively seek out leading conservation ranchers in the ecoregions I visit, including Zimbabwe, South Africa, Namibia, Australia, New Zealand, Argentina, Chile, Canada and most of the western rangeland states in the United States. I am intimately aware of the research that has been done on grazing management in most parts of the world. As part of my research activities, I worked with a number of leading ecological and grassland management academics as well as the leading conservation ranchers in those countries, especially Zimbabwe and South Africa. Since arriving in Texas in 1991, I have concentrated on researching the best management strategies to sustain and improve resources and livelihoods on rangelands.

THE NEED TO MANAGE FOR IMPROVED ECOSYSTEM FUNCTION

For humans to live sustainably, natural resources need to be used and managed in ways that prevent their depletion and that ensure their resilience for self-replenishment. To ensure the long-term sustainability of these resources, agricultural production should be guided by policies and management protocols that support ecologically healthy and resilient ecosystems and that mitigate anthropogenic greenhouse gas (GHG) emissions. Healthy agro-ecosystems are considerably more productive, stable and resilient than those in poor condition. Maintaining or enhancing the productive capacity and resilience of rangeland ecosystems is critical for the people who depend on them for their livelihoods and for the continued delivery of rangeland ecosystem services for the broader benefit of societies around the world. Such services include the maintenance of stable and productive soils, the delivery of clean water, the sustenance of plants, animals and other organisms that support human livelihoods, and other characteristics that support aesthetic and cultural values (Daily 1997; Grice and Hodgkinson 2002). While ranch livelihoods depend on healthy ecosystems, the value of ecosystem services to society is worth more than mere agricultural earnings. High soil carbon is the foundation of a healthy ecosystem. Rangelands are a huge sink for carbon dioxide (CO2) but most rangeland is degraded to some degree, and regenerative grazing will be needed in most situations to improve ecosystem function. To remain economically viable, managers must maintain or improve the biophysical functions and processes necessary for sustaining ecosystem health and resilience, including soil organic matter accumulation, solar energy capture, water infiltration, and nutrient cycling while also maintaining ecosystem biodiversity. In the long term, this strategy provides the greatest cumulative production potential and economic profits without decreasing delivery of ecosystem services for society.

The ability of food production systems to meet the demands of burgeoning human populations with higher per capita consumption depends on the alignment of increased production with the maintenance of healthy ecosystems and GHG mitigation. Solutions to produce such alignments must maintain the terrestrial and atmospheric natural resource base. At the same time they must address environmental, social, cultural and economic complexity, tradeoffs among different choices and they must also address unintended consequences. In contrast to the deficiencies of many traditional agricultural production systems, ecologically sensitive management of ruminant livestock in native perennial rangelands can positively contribute to critical ecosystem services, including carbon sequestration, maintenance of stable and productive soil structure, maintenance of functional water catchments and delivery of clean water, production of healthy food, protection of critical wildlife habitat, and enhancement of biodiversity (Liebig et al. 2010; Delgado et al. 2011).

In this paper I indicate how livestock management can facilitate the provisioning of essential ecosystem services, increase soil carbon sequestration, reduce GHG emissions and reduce environmental damage caused by current agricultural practices. I outline the value of using conservation-based grazing management and the potential for improvements in grazing management to enhance carbon sequestration through the sustainable, regenerative use of natural resources.

RESTORING SOIL CARBON ON RANGELANDS

The loss of soil carbon is extremely damaging in a number of ways. Loss of soil carbon negatively impacts ecosystem function and the provision of vital ecosystem services. The most limiting factor to ecosystem function and productivity on rangelands is the amount of water entering the soil. Water entering the soil and water retention in the soil are both directly influenced by soil carbon content. Thus loss of soil carbon causes degradation that affects all ecosystem processes (Thurow 1991). The amount of carbon in soils is directly related to the diversity and health of soil biota and as these microbes are dependent on plants, the manner in which we treat plants is critical to restoring soil carbon levels (Bardgett and McAlister 1999; Sacks et al. 2014). Nearly all organic carbon sequestered in soils is derived from the atmosphere by photosynthesis in plants and other organisms and converted to complex organic molecules in the soil by bacteria and fungi operating synergistically with insects and animals. In rangelands the influence of livestock can result in losses or gains in soil carbon depending on how the plants are managed. Poor grazing management that maintains grazing pressure without respite for plants to recover causes degradation, while grazing that defoliates plants moderately and provides for recovery before the plants are grazed again reverses degradation and increases the amount of carbon sequestered in the soil.

THE IMPACT OF CONTINUOUS GRAZING

Prior to man herding grazers in sedentary circumstances, large herds of wild grazers lived under free-ranging conditions over the world's grazing ecosystems. The co-evolution of plants and herbivores under changing environmental conditions has resulted in highly resilient grazed ecosystems that support more animal biomass and sustain considerably higher levels of herbivory than other terrestrial habitats (Frank et al. 1998). Grazing, fire and fluctuating climatic regimes create the dynamic resilience of organisms that respond constantly to biophysical events. As a consequence, most ecosystems never reach a steady state or climax seral stage (Pielou 1991). Rather, periodic disturbances rejuvenate and transform landscapes with respect to soil nutrients and structure, plant species composition, structure and biodiversity (Hulbert 1988). Although grazing pressure can be intense at some sites in free-ranging conditions of grazed ecosystems, concentrated grazing seldom lasts long when the movement of herbivores is not restricted; instead grazed plants are typically afforded time for inter-defoliation recovery when herds move to new feeding grounds (Frank et al. 1998).

Unfortunately, the replacement of free-ranging wild herbivores with livestock managed by humans has frequently led to severe degradation of rangelands. Domesticated livestock have become sedentary as humans restricted their movements across landscapes, suppressed periodic fire, and eliminated large predators (Milchunas and Lauenroth 1993). This has led to the removal of periodic animal use and positive impacts of animals on plants followed by the key revitalizing element of periodic recovery from defoliation for plants and to decreased nutritional quality and health for herbivores (Provenza 2008). In many instances, pressure on grazed plants has been further elevated through the use of supplementary feed to retain high animal numbers during less productive periods (Oesterheld et al. 1992).

Animals do not graze uniformly over the landscape but repeatedly consume preferred plants and patches of vegetation. This selectivity is affected most by vegetative heterogeneity at the landscape level and to a lesser degree by plant heterogeneity at the feeding-station scale and by distance of forage resources from water (Stuth 1991). Overgrazing occurs when individual plants are subjected to multiple, severe defoliations without sufficient physiological recovery time. In turn, excessive herbivory removes threshold amounts of biomass and litter, causing soil exposure and degradation in heavily used areas (Thurow 1991; Teague 2011). The spatial arrangement and scale of vegetative patchiness are major determinants of patterns of grazing and site selection when livestock are stocked continuously in a given area. These factors combine to increase vegetative heterogeneity as the size of the grazing paddock increases, which typically causes heavy, repeated impacts on preferred areas while other parts of the paddock receive light or no utilization (Coughenour 1991; Fuls 1992; Kellner and Bosch 1992; Teague et al. 2004). Figure 1 illustrates the impact of grazing on a rangeland landscape. Note the uneven impacts that result in greater than expected impact on the favored areas and underutilization over the rest of the landscape.

These impacts over the heavily grazed portions of the landscape set in motion a degradation spiral. Droughts, which are common in many rangeland ecosystems, exacerbate the effects of chronic defoliation (McIvor 2007), causing preferred plants to be less productive and eventually perish unless afforded a recovery period. This increases the amount of bare ground and favors less desirable plants, which are more highly physically and chemically defended species of grass, forbs and shrubs (Briske 1991; Provenza 2008). Reducing stocking rates to low levels to reduce degradation often exacerbates uneven grazing impact because the most desirable areas and plants within them continue to be more frequently and intensively grazed while less desired areas and plants are visited less often (Teague et al. 2004). Therefore, while stocking according to forage supply is a crucial first step in sustainable rangeland management for livestock production, it must be applied in conjunction with other practices that increase animal distribution and movement, and that include periodic growing season recovery and short grazing periods to mitigate the damaging effects of repeated selective grazing (Morris and Tainton 1991; O'Connor 1992; Provenza 2008). This process of degradation causes loss of soil carbon as the amount of bare ground increases and as the most productive grasses that contribute most to sequestering soil carbon are replaced by less productive grasses. Thus the impact of overgrazing directly causes greater loss of soil carbon and a decrease in the amount of carbon sequestered.

MANAGING TO IMPROVE ECOSYSTEM FUNCTION

The key to sustaining and regenerating ecosystem function in rangelands is actively managing for reduction of bare ground, promoting the most beneficial and productive plants by grazing moderately over the whole landscape, and providing adequate recovery to grazed plants. These changes result in decreased soil carbon loss and increase carbon sequestration. Ecosystem function is enhanced when the amount of water entering and being retained in the soil increases. While many grassland ecosystems have been degraded through unsustainable livestock production practices, ranchers throughout the world have shown it is possible to use planned multi-paddock grazing to reverse degradation in areas with as little rain as 250 mm per year to areas receiving over 1,500 mm per year. This reversal is also possible on public rangelands, as demonstrated by numerous ranchers on privately owned ranchland in the Great Plains and western rangelands.

Restoring the ecological functionality of these degraded ecosystems necessitates the use of regenerative grazing management practices. Such grazing management has resulted in increasing forage productivity, restoration of preferred herbaceous species that were harmed by previous grazing practices, and increased soil organic carbon and soil fertility, water holding capacity and economic profitability for ranchers (Teague et al., 2011; Teague et al. 2013). In "across the fence" comparisons in semi-arid rangelands of Texas, planned multi-paddock grazing applied to areas previously degraded through prolonged continuous grazing resulted in carbon sequestration and soil organic carbon increases that lead to an estimated average difference of 30 metric tons of carbon per hectare over a decade compared to commonly practiced heavy continuous grazing (Teague et al. 2011). When domestic ruminants are managed in a way that restores and enhances grassland ecosystem function and where the only feedstock is grass produced via solar energy, increased carbon stocks in the soil will lead to larger and more diverse populations of soil microbes, which in turn increase carbon sequestration, including methane oxidation (Bardgett and McAlister 1999; Teague et al. 2013). Therefore, as long as management results in building soil health, and does not have other carbon inputs, grazing animals can lead to carbon "negative" budgets, i.e. more carbon enters the ground than is emitted, either directly via carbon loss from the soil or indirectly via ruminant greenhouse gas emissions (DeRamus et al. 2003; Liebig et al. 2010; Janzen 2010; Delgado et al. 2011).

Ranching in rangeland ecosystems is characterized by ever-changing and unpredictable environmental conditions and circumstances due to low, variable and spatially and temporally heterogeneous precipitation and plant productivity, and to fluctuating economic conditions driven by market price fluctuations and shifting social values. By using soil, water and plant resources efficiently and sustainably, successful rangeland managers enhance the health of the ecosystems upon which they depend, their profitability and their life quality, while also providing ecosystems services desired by society (Walker et al. 2002). They combine scientific principles and local knowledge to proactively manage animals to influence four ecosystem processes: efficient conversion of solar energy by plants; interception and retention of precipitation in the soil; optimal cycling of nutrients; and promotion of high ecosystem biodiversity with more complex mixtures and combinations of desirable plant species (Stinner et al. 1997; Reed et al. 1999; Savory and Butterfield 1999; Gerrish 2004; Barnes et al. 2008; Diaz-Solis et al. 2009; Teague et al. 2013). To accomplish this, successful managers apply the following five principles:

1. Provide sufficient forage for animals to select a diet of adequate quantity and quality;
2. Manage grazing so animals eat a wide variety of plants and decrease impacts on desirable plants;
3. Leave enough leaf biomass on defoliated plants to facilitate interception and infiltration of precipitation and to maintain sufficient photosynthetic capacity for rapid plant recovery;
4. Allow adequate post-grazing recovery to maintain plant vigor and desired plant composition; and
5. Plan and create the means to control grazing pressure in time and space to facilitate the previous four principles.

This has been achieved most successfully by using multiple paddocks per herd, or moving animals around by herding, or using fire to achieve light to moderate defoliation for short periods of time during the growing season followed by adequate recovery time before grazing again. Multi-paddock grazing thus facilitates grazing of the whole landscape by grazing one paddock at a time, as illustrated in Figure 2. Using many paddocks spreads the impact of livestock over the whole landscape, and by managing each subdivision to ensure moderate use in the growing season and adequate recovery, the negative impacts of grazing under continuous grazing (even at low stocking rates) are mitigated, resulting in much better ecological condition and soil health. This also facilitates selecting a wider variety of plant species, regulating how much of a paddock is grazed before it is vacated to recover and the length of time necessary to allow full recovery. The USDA-Natural Resources Conservation Service promotes regenerative multi-paddock grazing as the best means to improve soil health.

Superior results in terms of range ecosystem improvement, productivity, soil carbon and fertility, water holding capacity and profitability have been regularly obtained by ranchers using multiple paddocks per herd with short periods of grazing, long recovery periods and proactively changing recovery periods and other management elements as conditions change (Teague et al. 2011; 2013). One of the most important benefits of using planned multi-paddock grazing is that it facilitates making essential adjustments to all facets of management to avoid incurring negative impacts and taking advantage of positive events that occur. The main items that have been found to achieve best results include:

- Matching animal numbers to available forage at all times;
- Spreading grazing over the whole ranch;
- Defoliating moderately in growing season;
- Using short grazing periods;
- Allowing adequate recovery before regrazing;
- Grazing again before forage becomes too mature for good animal performance; and
- Proactively changing these elements according to changing conditions.

Many ranchers around the world have used these proactive, multi-paddock grazing management principles to restore ecosystem services and productivity on degraded rangelands. Many ranches in drier ecosystems were initially so bare of vegetation that they would have been classified as desertified. The overwhelming majority of conservation awards to ranchers operating on native rangelands have gone to ranchers using multi-paddock grazing of one form or another. These ranchers operate in extensive, heterogeneous landscapes, where they are confronted with the adverse effects of uneven grazing distribution, and their collective ecological and management knowledge of multi paddock grazing indicates the necessity of using proactive, multi-paddock grazing management to achieve superior outcomes. This form of grazing management has been shown to be effective in restoring plant cover of the soil, plant species composition and productivity on millions of hectares on four continents, primarily in semi-arid and arid areas, since the 1970s. Sacks et al. (2014) have postulated that it has the potential to remove excess atmospheric carbon resulting from anthropogenic soil loss and degradation over the past 10,000 years, as well as industrial-era greenhouse gas emissions. This sequestration potential, when applied to the approximately 5 billion hectares of degraded range and agricultural soils, could theoretically return 10 or more gigatons of excess atmospheric carbon to the soil annually and lower greenhouse gas concentrations to pre-industrial levels in a matter of decades. As a low-tech approach it is inexpensive and entails little of the risk inherent to large-scale, industrial environmental solutions. On public lands where permanent structures are not favored, the common practices of herding, or forming paddocks with moveable, solar-powered electric fences offer eminently practical and low cost solutions.

An analysis of ranching failures (Teague et al. 2013) reveals many common problems that need to be avoided. They include:

- Too many animals before soil and plants had improved
- Not developing suitable stock water system
- Inadequate planning
- Not adapting as conditions change
- Defoliating too heavily in growing season
- Long grazing periods
- Inadequate recovery before regrazing
- Expecting improvements where conditions are very limiting

CONTRADICTORY RESULTS FROM RESEARCH AND RANCH BASED EXPERIENCE

Most research related to grazing management (reviewed by Briske et al. 2008; 2011), and thus carbon sequestration potential on rangelands, has been short term and has examined the issue from a reductionist viewpoint that ignores the critical influences of scale (Figure 3), and does not use proactive multi-paddock grazing to achieve sound animal production, resource improvement, and socio-economic goals under constantly varying conditions on rangelands (Teague et al. 2013). Figure 3 superimposes hypothetical research plots on this landscape at the scale of most grazing management research. Note that no matter which plot or group of plots is chosen NONE of them shows the impact that occurs over the whole landscape. This illustrates how poorly most research on this topic has misrepresented what actually happens on commercial ranch landscapes.

In a recent review of the literature to determine why many research projects have arrived at conclusions that are contradictory to results obtained worldwide on ranches managed for conservation goals, Teague et al. (2013) report a number of key reasons. First, the application of experimental treatments in controlled grazing experiments has, in general, not taken into account commonly recognized principles to maintain health and vigor of plants and nutrient intake of animals. In addition, the spatial limitations, short-term nature, and inflexible grazing treatments imposed in most experiments have prevented researchers from adequately accounting for the spatial heterogeneity of vegetation, temporal shifts in weather, plant composition, time lags in learning necessary for animals to perform to their potential with changes in management, and stocking rate adjustments that characterize most rangeland production systems. Such experimental limitations have frequently led to results that imply multi-paddock grazing treatments are no better than, or inferior to, lightly or moderately stocked continuous grazing treatments, when in each case the reaction of organisms of interest are at the mercy of these factors without management to adjust to these factors.

By contrast, many ranchers have achieved excellent animal production and soil and vegetation improvements using multi-paddock grazing and find that the flexibility and timeliness of feedback inherent in multi-paddock grazing facilitate improved management compared to continuous grazing. They have responded to changing environmental circumstances through the use of proactive management practices that include regular resource monitoring and timely adjustments in livestock placement and numbers. In complex ever-evolving ecosystems, components emerge, change, and then disappear and managers cope and then capitalize on changes they help to initiate (Teague et al. 2013). We typically long for a standard recipe to ensure that we sustain the status quo, despite knowing that we are awash with variability in social and biophysical environments with changes largely out of our control. Instead, good management of complex systems requires flexibility, and less attempt to *control* than to *understand* and *respond appropriately and continuously* to changes as they arise. In the context of productive landscapes, successes should be judged at the system level and based on whether the system can support those who depend on it.

A second and related reason most grazing trials have not corroborated successful ranch-scale multi-paddock grazing experiences is that they have not adequately addressed animal-plant interactions at appropriate scales. Without management intervention, plant- and area-selective grazing increases with increasing paddock size and time. In general, small-scale and short-term grazing trials have not accounted for the uneven distribution of livestock in large continuously grazed paddocks, which leads to localised pasture degradation over time (see Figure 3). Neither has it accounted for the more even distribution of livestock in small continuously grazed research paddocks that leads to more even utilization. In addition, ranchers achieving positive results with planned multi-paddock grazing generally proactively manage recovery time to provide consistently adequate physiological recovery for defoliated plants. Either way, the conclusions are affected by the design and implementation of the study.

By ignoring successful restoration examples of conservation award winning ranchers who use planned multi-paddock grazing to proactively achieve desired goals and avoid negative consequences, research scientists have grossly underestimated the potential of management to facilitate carbon sequestration on the rangelands of the world. Consequently, they do not represent the subject adequately because conclusions have been selectively chosen so as to exclude published data showing superior results from proactively managed multi-paddock grazing at commercial ranch scales. The studies referenced underestimate positive benefits to soil and ecosystem function, so they almost certainly underestimate the potential of rangelands to sequester carbon and benefit ecosystem function overall.

Research that concentrates only on differences in productivity without meaningfully taking into account negative impacts on the environment can lead to misleading extrapolations. Such conclusions cloud rather than enhance knowledge about sustainable grazing management and have no relevance for practical grazing management applications. Further, published multi-paddock grazing research from Australia, Southern Africa, Argentina and the United States have arrived at the opposite view to those expressed by Briske et al. (2008; 2011) when: (i) conducted at the scale of ranching operations, (ii) proactively managed as conditions changed to achieve desired ecosystem and production goals, and (iii) measured parameters indicating change in ecosystem function (see Teague et al. 2011; 2013).

CONCLUSIONS

For soils to be a net sink for GHGs rather than a major source of GHGs as at present, grazing management on rangelands must build rather than compromise soil carbon and soil microbial functions, and reduce creation of bare soil and resulting erosion more effectively. With appropriate management in grazing situations, ruminant livestock have an important role to play in achieving these goals. They facilitate carbon sequestration in the soil to more than offset their GHG emissions, while providing essential ecosystem services that enhance both human and ecosystem well-being, such as improving water catchment function, stabilization of soil and soil fertility, carbon sequestration, enhancing wildlife habitat and biodiversity, and promoting the ability of local populations to sustain livelihoods.

Achieving these positive results on rangeland requires a change in land management practice. Emerging research suggests that non-conventional grazing management on cultivated pastures and rangeland might at least reduce GHG footprint, and at best, turn livestock management practices into a tool to improve the global environment, local ecosystems, economies, and even human health. Based on this research and observations on ranches around the world, planned multi-paddock grazing management can increase soil plant cover, plant productivity and soil organic carbon and thereby provide carbon sinks that far exceed the production of GHGs from the grazing ruminants. Planned multi-paddock grazing management also results in less erosion and improved hydrological processes that reduce non-livestock related GHG emissions. Where planned multi-paddock grazing has been applied in semi-arid and arid lands for some time, ephemeral streams have reperennialized and biodiversity has recovered to varying degrees. Soil building grasses, nitrogen fixing native leguminous plant species, and even pollinators have come back. In short, planned multi-paddock grazing management appears to be an effective and low-cost way to reverse the deleterious effects to ecosystems of long-term continuous grazing.

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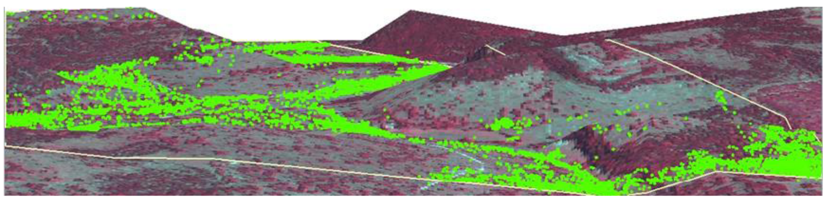

Figure 1. The heterogeneous impact of continuous grazing over a ranch landscape. The green dots are GPS locations of collared cows over a year of grazing. Plants in the heavily frequented areas are overgrazed, causing increased bare ground, poor plant productivity and replacement of desirable plants with less desirable plants degrading ecosystem function.

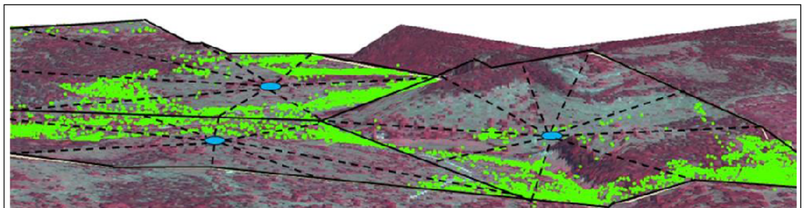

Figure 2. How multi-paddock grazing can facilitate better ecological condition and soil health. All animals graze in a single paddock for a short period before grazing the following paddocks in turn. Each paddock is afforded sufficient time of recovery before being grazed again. This results in spreading the grazing over the whole landscape and facilitates the animals selecting a wider variety of plants. This allows the manager to regulate how heavily each paddock is grazed and ensure each paddock has recovered before being regrazed. Done correctly this reverses degradation.

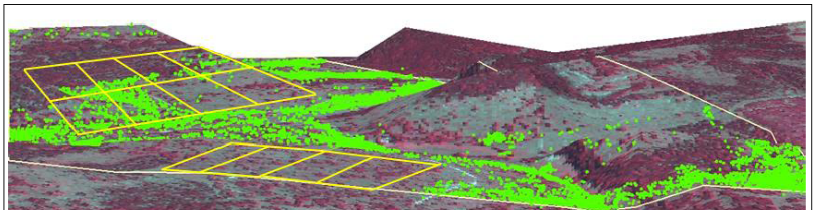

Figure 3. How previous small-scale plots misrepresent continuous grazing impacts on ranch landscapes. The small areas superimposed on the landscape represent small plot research areas commonly used to determine what impacts the grazing animals are making. Clearly none of them represents the impact being made in the ranch scale paddock. This has resulted in research projects underestimating the impacts of continuous grazing in large commercial scale ranches.

QUESTIONS SUBMITTED FOR THE RECORD TO RICHARD TEAGUE

Question 1. During the hearing there was extensive discussion of the use and value of applying compost to rangelands to sequester carbon (C) in soils. Is the application of compost a requirement to increase the sequestration of carbon on the public rangelands and forests?

Answer. No, it is not essential. My research has been entirely on native rangelands where I have shown with rigorous quantitative data that real world practicing ranchers can create a differential uptake of soil carbon compared to their adjacent peers through regenerative grazing management practices alone. To be explicit, by comparing ranches in North Texas we demonstrated an ability to take up an average of 30 tons of *additional* carbon per hectare over a 10-year period with regenerative grazing relative to the commonly practiced heavy continuous grazing on neighboring ranches (Ref: Teague et. al. 2011). Although this was in a prairie ecosystem in a different environment, this rate of uptake at 3 t C/ha/year is larger than that seen so far resulting from addition of compost on the Wick Ranch and at considerably lower cost. The NRCS has measured similar responses to regenerative grazing management in many other U.S. grazing ecosystems. I do believe the Wick Ranch work is very encouraging, and may lead us in a direction where compost also plays an important role. Compost may be an especially important and valuable addition in the near term, given an abundance of both highly degraded lands and waste. That said, rigorous research on grazing, compost and other techniques (e.g. biochar) is still quite rare, so we won't understand potential, variability and controls until more research is done—something I believe should be a priority.

Question 2. Livestock have been widely identified as a major contributor to climate change because of the carbon dioxide (CO2) you say could be sequestered, wouldn't that actually make things worse because of the additional methane they would produce?

Answer. When domestic ruminants are managed in a way that restores and enhances grassland ecosystem function and where the only feedstock is grass produced via solar energy, increased carbon stocks in the soil will lead to larger and more diverse populations of soil microbes, which in turn increase carbon sequestration, including methane (CH_4) oxidation. Therefore, as long as management results in building soil health, and does not have other C inputs to the management system, grazing animals could lead to carbon "negative" budgets—more C enters the ground than is emitted, or indirectly via ruminant emissions (Delgado et al. 2011).

Most cattle produced in "developed" world countries from conventionally grazed rangelands and forage-based grazing systems are finished for the marketplace on high starch, grain-based feeds. Proponents of this finishing method claim that, compared to grass-finished beef production, intensification of production through the use of grain-based feeds results in lower greenhouse gas (GHG) emissions per marketed animal because it reduces the overall production time to slaughter. However, this may not be the case when the full GHG emissions associated with the production of grain-based feeds are taken into consideration. Not accounting for the substantial GHGs emissions resulting from crop production that include soil erosion, greatly underestimates GHG production associated with the industrial agriculture paradigm for producing beef (see Figure 1).

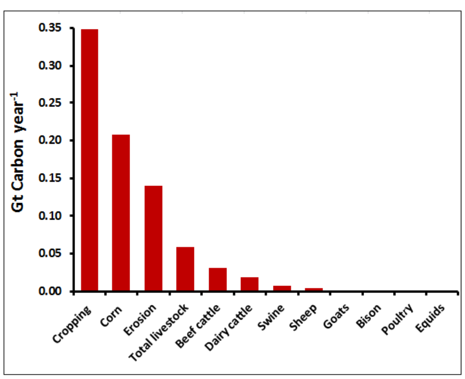

Figure 1. Estimated US greenhouse gas emissions for 2012 from total crop production, corn, total livestock and livestock by class (EPA 2013), and soil erosion (Lal 2003)

Appropriately managed grazing resources can increase soil fertility, minimize soil erosion and sequester considerably more C than the C-equivalents emitted as GHGs by the animals grazing them. Regulating ruminant-based enteric CH_4 is immaterial in the overall C footprint of beef cattle production from grassland. This is based on data from the Northern Plains where, when using a modest annual soil organic carbon (SOC) sequestration rate of 0.17 tons/ha with the continuously grazed forage base, both heavy and moderately stocked grazing systems produced substantial carbon sinks of −0.618 and −0.783 tons CO_{2equiv}/ha/year, respectively. Overall these systems yielded −0.026 and −0.145 tons CO_{2equiv}/kg-animal gain while the enteric methane was reported to be 0.484 and 0.176 tons CO_{2equiv}/ha/year (Liebig et al., 2010).

Question 3. Do public land grazing lands require grazing livestock in order to be ecologically healthy and sequester carbon or are there ways to increase soil carbon sequestration on rangeland and forests that do not require animal impact? If so, do you think these alternative methods would be practical to use on public lands?

Answer. Prior to European man's arrival, grassland ecosystems in North America were characterized by free-ranging herds of large, migratory herbivores which moved constantly from and avoided fouled grazing sites seeking water and nutrients, and in response to changes in the vegetation due to topography, edaphic effects and variable and patchy precipitation to improve their diet quality and grazing efficiency (Frank et al., 1998; Teague et al., 2013). They also moved for a variety of other reasons including social factors, fire, predators, and movements by herders and hunters. Therefore, although grazing was intense at any particular site, such concentrated grazing seldom occurred at length and defoliated plants were usually afforded time and growing conditions to recover (Frank et al., 1998). This periodic vegetation defoliation and regrowth created by migratory herbivores contributed to ecosystem stability and the availability of high quality diet for these herbivores.

A further factor contributing to stability in these ecosystems is that grazers are important regulators of ecosystem processes in grazing ecosystems (Frank and Groffman, 1998). Ungulates in grazed ecosystems increase forage concentration, grazing efficiency, forage nutrient concentration and above-ground plant production (Frank et al., 1998). They also improve mineral availability by enhancing soil microbial nutrient enrichment and root zone processes that ultimately feedback positively to plant nutrition and photosynthesis (Hamilton and Frank, 2001) in addition to increasing nutrient cycling within patches of their urine and excrement (Holland et al., 1992). Consequently, grazing results in maximum vegetation productivity at intermediate levels of defoliation and low levels of production at excessively low or high levels of defoliation (McNaughton, 1979; Dyer et al., 1993; Turner et al., 1993).

Under these conditions grassland ecosystems were functionally efficient and stable by virtue of: efficient conversion of solar energy by plants; interception and retention of precipitation in the soil; optimal cycling of nutrients; and promotion of high ecosystem biodiversity with more complex mixtures and combinations of desirable plant species. If large herbivores are removed from these ecosystems, the ecosystems quickly cease to function efficiently. Undefoliated grass accumulates to shade new leaves, reducing photosynthetic energy capture, eliminating nutrient inputs from dung and urine, and reducing microbial cycling of nutrients by soil microbes. This reduces all forms of life that depend on energy and nutrients from plants, including soil microbes, insects, birds and animals in the ecosystem. The whole ecosystem degrades.

Mowing can remove plant material to allow photosynthesis but does not efficiently recycle nutrients, so apart from being impractical for vast areas of grasslands; it results in less efficient ecological function. Fire can also remove plant material but by causing bare ground for extended periods, the amount of water entering the soil is reduced and erosion and loss of soil carbon is increased. This is particularly damaging as the amount of precipitation entering the soil is the most important factor limiting ecosystem function in the drier grazing ecosystems that make up most of U.S. public land grassland ecosystems. Even in more moist grazing ecosystems, such as the tallgrass prairie, burning alone results in loss of nutrients and biodiversity relative to when grazing is part of management (Seastedt 1995). Fire is also very hazardous in many areas and appropriately managed grazing reduces this hazard.

Another non-grazing method involving wetlands can also put significant carbon back in soils. However, as wetlands make up a very small area in U.S. public lands I will merely direct you to the excellent work of Dr. Lisamarie Windham-Myers of the USGS in Menlo Park, CA who is demonstrating some very high local capacity for increased carbon storage. Wetlands may have lower capacity due to lower total areas, but very high carbon uptake rates could make them an important part of a holistic plan to catalyze putting carbon back in soils.

Question 4. During the hearing there was a challenge to the assertion that grasslands and related ecosystems store the most carbon in their soils in the most stable way compared to other methods. Will you provide more support for this assertion?

Answer. I concentrate on management of grazing lands to restore ecosystem function but there are more authoritative scientists to answer this question. The references that follow are from their published work on the subject. Terrestrial ecosystems are an important global carbon sink and the size of the sink is related to global grazing lands (Schimel et al. 2011; Prentice et al. 2001). Grasslands, among the largest North American biomes, covering >125 million ha (Küchler 1964), store more carbon in soils than other ecosystems and are more stable long-term as carbon sinks than forests, which store more tons per hectare but do so by having higher above-ground biomass. This poses a considerably higher risk from fire and other hazards than grasslands that have the majority of their biomass and carbon below ground (Pacala et al. 2001; White et al. 2000).

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Mr. BISHOP. Thank you very much.

Supervisor Martin, I appreciate you being here, you are recognized.

STATEMENT OF TOMMIE MARTIN, SUPERVISOR, GILA COUNTY, ARIZONA

Ms. MARTIN. Chairman Bishop and Ranking Member Grijalva, esteemed Members, thank you for having me here.

In addition to being a Gila County Supervisor for the past 10 years, I am a rancher, and have been a consultant on ranch management and rangeland improvement efforts here in the United States, in Mexico, and East Africa over the last 30 years. Over 130 years ago, when my great-grandparents first settled in what would become Gila County, this process of capture, convert, and collecting carbon that we are talking about today was functioning with high efficiency.

My great-grandmother described to me land that was open, rolling, grassy hillsides with stringers of trees in the upper elevations. She called it Pine Savannah. Today it is a tree brush thicket with little to no grass. She said there may have been 30 trees to the acre. Today there are up to 3,000. She describes streams that were perennial and full of the native brown trout. Today we have lost 1,000 miles of those streams and the trout within them. Much of the wildlife she discussed—wolf, grizzly, clouds of wild canary—are gone entirely. We now know that this landscape was a grazable woodland, sequestering vast amounts of carbon in the soil.

So, why the change? Simple. A change of managers. She inherited land managed by the native people of the time. And don't kid yourself, they did manage it. I inherited land managed by the Federal Government, who took over shortly after my pioneer family arrived, and continues today.

One result is an unprecedented wildfire fuel buildup. In my county, and much of the West, we live in this virtual sea of gasoline. I call it 100 years of failed Federal policy. As bad as it is, though, based on my personal experience, it is not too late to reverse this trend. Some 25 years ago, my sister, her husband, and I decided to experiment using cattle to help restore badly degraded land, and we picked some of the worst we could find in Nevada: the banks of an old cyanide leach pond from a gold mining operation. The ground was virtually sterile. But using cattle to incorporate organic matter into the soil, we got amazing results in just a year. You have the pictures in my written statement. It was pioneering work then; it is now routinely being used around the world.

So, it is not a question of knowing how to reverse the deterioration we see and generate a wide range of benefits, including sequestering carbon. It is a matter of will we. Ultimately, this is not an environmental problem; it is a people problem. It will take considerable cooperation by everyone, and help from Congress.

I am asking the committee today to consider establishing 100,000-acre demonstration areas scattered throughout the West to implement very low-cost, high-benefit practices on Federal lands that can demonstrate, in a large-enough area, these principles. I would like at least one in Gila County. As noted, benefits would include carbon capture, endangered species restoration, hydrological improvements, opportunities for western citizens to once again live off the land.

I would like to reference the Deseret Ranch the Chairman talked about, in northeastern Utah. They use mixed livestock as their management tool, and they have managed 202,000 acres of mixed U.S. Forest Service, BLM, and private land to meet any conceivable environmental need of many, many species, while netting $3.5 million, or $17.33 an acre. In my county of Gila, we have three million acres of Federal land, and the ranching community there might net $.05, a nickel.

You see PILT and other Federal payments are insufficient and, I believe, unnecessary if Federal land management policies could be reserved to allow environmentally sound approaches. There simply isn't enough money in the treasury to solve this problem. But there is in the economy.

A good example of the cooperation necessary to make this happen is how the environmental groups in our area have reacted to the obvious result of their decades-long opposition to logging and other methods of managing our forests. In my opinion, they were dead right about the problems they were seeing, but wrong on how to fix it. To their credit, they have admitted publicly that they were wrong. To their greater credit, they have been working constructively to correct it. Unfortunately, I can't always say the same for the U.S. Forest Service, even though many of the folks working for them try.

An important cooperative effort in my area is an excellent example of a project that would not only help restore health in the forest, result in more carbon sequestering, and add wealth to the local economy, but a compromised Federal contracting process and prevailing agency culture is about to foil the project.

In the meantime, to reduce the risk of catastrophic fire and buy time until industry has returned to the equation, my county in Gila developed a pioneering program to place water storage tanks around the county so helicopters could quickly put out small fires before they get out of hand.

Since 2006, we have put out hundreds of small fires. The vast majority didn't get over 15 acres, and 18 of them were classified by the Forest Service as having catastrophic potential.

In summary, we can sequester huge amounts of carbon on Federal lands, reverse their deterioration, and generate many environmental and economic benefits. But, based on my experience, it will take direction to the agencies and Congress to accomplish this. I look forward to discussing this further with the committee. Thank you.

[The prepared statement of Ms. Martin follows:]

Prepared Statement of Tommie Cline Martin, Gila County Arizona Supervisor, District One

Chairman Bishop, Ranking Member Grijalva, distinguished members of the Public Lands and Environmental Regulation Subcommittee. I very much appreciate the invitation to present this written testimony to your House Natural Resources Subcommittee on Public Lands and Environmental Regulation Hearing on 'Increasing Carbon Soil Sequestration on Public Lands', June 25, 2014.

INTRODUCTION

Let me begin by sharing a John F. Kennedy quote, "The great enemy of the truth is very often not the lie—deliberate, contrived and dishonest, but the myth—persistent, persuasive and unrealistic".

In the carbon sequestration conversation, there IS a real, a simple, an economically positive alternative to our current Cap and Cut regulatory approach to the atmospheric carbon dioxide problem—and that is a Capture and Convert or Collect path through photosynthesis.

Photosynthesis is the natural process of taking carbon and water and sunlight and making plant mass. Both forests and grasslands sequester carbon—forests mostly store carbon above ground in their woody tissue but not so much through their fairly shallow, lateral root systems. Healthy grasslands, on the other hand, have a very dense and very deep root system, and use it to store carbon in the soil as organic material and humus (see figure 1—Tree Roots; figure 2—NRCS Prairie; and figure 3—Calif grass).

However, in the last 200 years our soils have lost half of their carbon reserves because nearly every practice we have brought to the land—be it deforestation, the plow, the annihilation of the buffalo, the fencing up of the land, you name it—the cumulative effect has been carbon loss in soils of all types.

By the same token, for almost 50 years we have had the knowledge and the expertise to reverse this loss and refill these reserves with atmospheric carbon dioxide. For at least the last 30 years, many of the elements have been proven through research and replication.

Our soils represent both a short- and long-term carbon storage medium. Even in their depleted state, soils still contain more carbon than is in all of the existing terrestrial plants AND in the current atmosphere combined—and STILL have the capacity to store at least half again as much in just replacing the loss of the last 200 years.

While soils beneath forests and rainforests can be very fertile, the world's deepest, richest soils evolved as grazing land. Because forests mostly store carbon above ground in their woody tissue and grasslands store carbon in the soil, in a fire, forests release most of their stored carbon to the atmosphere, but in grassland fires most of the carbon remains in the soil.

Now for the myth—when all is said and done, we are not dealing with a carbon problem, but with a people and their myths problem. To begin to manage our lands to intentionally reverse their carbon loss and to re-sink carbon into their reserve space, we must shift our collective worldview and land management path from our current mechanistic one to a holistic one.

From a holistic perspective, it is easy to recognize, appreciate and work with the symbiotic, evolutionary relationship between grazers and grasslands. Once we reattain the bone deep understanding that the grass needs the grazer for survival every bit as much as the grazer needs the grass, we then begin to understand how—together and managed holistically—they CAN restore atmospheric carbon dioxide to pre-industrial levels and in a fairly short timeframe.

So far, we've looked at this option as real and simple. Now let's briefly touch on economically positive.

Our public land forests, by any honest measure, are either decadent or dying or dead and they are in these conditions, in my opinion and experience, due to 100 years of failed Federal policy. Also in my opinion, the only real way out of this dilemma is to be able to return industry to the forests and allow them to profitably reduce the massive fuel loads—which to industry represent products—and do so catering to both the environmental dictates of a desired future condition and the economic dictates of industry. Holistic, adaptive management driven by monitoring results of both sectors need to guide the process.

The task of returning sustainable health, functioning and productivity to our public lands forests is enormous, imperative and almost too late. For many years we have acted as though we could buy our way out with subsidized Federal programs of one sort or another. It is my firm belief that there IS NOT enough money in the Treasury to solve this critical situation . . . but that there IS enough money in the Economy.

Since 2006 in Arizona we have been trying to make just this scenario happen through our Four Forest Restoration Initiative (4–FRI) on the Apache-Sitgreaves, the Tonto, the Coconino and the Kiabab Forests.

As for our grasslands and rangelands, I would turn your attention to Deseret Ranch, a 202,000 acre public and private land ranch in northeastern Utah, that has been practicing and helping develop these holistic management principles since the late 1970s/early 1980s. I am sure you know it well, Mr. Chairman, since it is in your congressional district. For any member who might be interested I know we can go visit so you can see for yourselves that every known environmental need for every possible plant, animal, fish, amphibian or bird species is being met on that ranch—and carbon has and is steadily being sunk into the land. And they are doing so while netting $3 million per year—or $14.85/acre.

By contrast, the Arizona County I represent, Gila County, is comprised of 3 million public land acres and our ranching community—following mechanistic rules and regs—not only may not be meeting the environmental needs of any species, they quite literally net approximately $0.05/acre—yes, a nickel. They, too, need to be allowed to follow these holistic principles targeted specifically at capturing, converting and collecting carbon, catering to both the environmental dictates of a desired future condition and the economic dictates of industry.

Their profit would come from the products of meat, milk, hair, wool, etc. and, again, Holistic, adaptive management driven by the monitoring results of both sectors would guide the process. They would move from federally subsidized ranchers to profit centers—again, a "money from the Treasury vs. the Economy" conversation.

Let me now try to translate these ideas into some examples I have been involved in.

PERSONAL HISTORY

For context, I was born and raised on a Public Land (USFS) cattle ranch near Payson, Arizona which is in the center of the state. My mom and her folks were also born and raised around Payson and my dad and his folks were from the Young, Arizona area a bit of east of Payson. My great-grandparents had come into the area beginning in the late 1800s.

My folks claimed they could not hire the help needed to run the ranch, so they raised it. As a result, early on I had an extensive and thorough working knowledge of all aspects of the land-animal-plant-human and/or environmental-social-economic interactions of ranching—and particularly of public land ranching. Getting a college education was a given in my family, and I came out of Arizona State University with an Agri-Business Management Degree.

My employment path led me to go to work for and with Allan Savory in 1985 at his Center for Holistic Resource Management. In the late 1970s, I had visited several ranches within Arizona who were working with him and getting very interesting early improved land and animal health and productivity results and in 1980 I heard him make a presentation to the New Mexico Cattlemen's Annual Meeting—and found what would become my favorite windmill to tilt! I'm here today, in fact, tilting that same windmill.

More than anything else, Allan gave me the language I needed to talk about the land-plant-animal relationships that I and my family intuitively knew and actively worked with; and with the early results coming out of the Holistic Model, he gave us the impetus to refocus on developing and catering to land-plant-animal dictates rather than calendar-clock dictates.

However, ultimately, this led us to selling our ranch some 15–20 years later because it just became too painful to have proved to ourselves what should and could be; to not be allowed to do it because of increasingly rigid and mechanistic Federal rules and regulations; and to know that these Federal rules and regs, when followed, force ranchers into wholesale overgrazing and puts us in a position of being the instruments of our own demise.

EARLY DEMONSTRATIONS

While working with the Center, one of my areas of responsibility was as the area representative for the Great Basin and the Southwest. I have a sister and brother-in-law, Jerrie and Tony Tipton, who ranch on public land (USFS and BLM) in Nevada. After teaching and consulting on Holistic Management for several years, I began wanting to turn the more theoretical elements of the process into results—because when all is said and done, if I can't translate the theory, the research, the intellectual ruminations into results through practical application, I begin to think I'm furthering the problem and not the solution.

Something Tony and Jerrie and I had long been interested in—and pushed the envelope of—was soil fertility. This led us to digging up many plants in many soils types looking at root responses in different soils and under different grazing patterns. It led us to experiment with and observe free choice mineral use by the livestock and to record dramatic positive changes in pastures as livestock, through their mineral selection for elements missing or scant in the pasture, put those minerals back on the ground through their urine and manure—and pastures start the transition from a wheatgrass monoculture to a highly diverse native grassland. It also led us to the Soil Food Web work of Elaine Ingham's and that whole piece of the soil biology puzzle.

I had long conversations with Tony and Jerrie about the whole Federal soils classification efforts, where their land managers based their management dictates and direction solely on the chemistry and physics of soil types (and still do) . . . with NO consideration given to the biology of soil or to the dramatic difference its presence or absence brings to sustainable soil health, functioning and productive.

Those of us involved in these early efforts were learning the hows and whys of vastly improving a pasture through planned grazing, and doing so fairly quickly, but there were no discussions at the time on how to get the process started on the vast tracks of bare ground so prevalent on western public lands and played out farm ground.

This, and more, led the three of us to decide we wanted to take a closer look at the Carbon Cycle of carbon plus water plus sunlight equals photosynthesis which translates into plants of all types—food, feed, grass, trees (and so seeds, nuts, fruits and so on)—to learn if and how we could 'jump start' it, what influence that might have on the water cycle and the energy flow, and to better understand the use of animal impact as a powerful tool.

In the middle of Tony and Jerrie's ranch was a mining operation called the Austin Gold Venture, with Inspiration Copper and FMC (Food Manufacturing Corp) the principles in the venture. Part of their mining process was a fenced Cyanide Leach pond behind about a 15 acre dam of virtually sterilized soil, that was about 3 stories (30 ft) tall with a northern, western and southern aspect, and a 1–1½ slope (steep slope).

This was in the fall of 1989, and they had a 600+ head herd of cows and big calves that needed moved from the northern end of the ranch to the southern end and which would take them by this site. We got agreement from the mine manager to use the herd to incorporate carbon, brought in from off-site in the form of organic meadow hay, into the dam face to feed the near-sterile soil and see what would happen (the mine was in the process of winding down their operation over the next several years and were interested in possible reclamation potential since what we were about to do had not been tried on any land, much less mine spoils land—although what we did has since been widely duplicated on mine spoils, burned areas, depleted farm land, etc.).

So on October 1, 1989 the three of us, and a man we hired to help, began to feed 32 ton of organic meadow hay (all we could afford) to 600+ head of cattle on the dam face of that cyanide pond over a 6-day period and then moved them on to First Canyon. In the next 12 months, the valley in which this pond was located received 6″ of moisture in the form of some snowfall and some rainfall. We returned to the site in October of 1990 (1 year later) and clipped and weighed over 3 ton/acre of organic meadow grass and forbs that had grown and covered the dam (see figure 4—AGV #1; and figure 5—AGV #2).

When we got to First Canyon with the herd we decided that before we would turn them loose to disperse into the canyon that we would have them impact an area of very decadent and dying sage brush. We wanted them to incorporate what they could of on-site carbon (vs. off-site) into the soil and generally open up the area so sunlight could get below the dense sagebrush canopy and create more open inner spaces between the pinyon trees in the area.

As you can see in the pictures, one of the most unexpected but exciting results of the next fall's monitoring of that site was the pinyon nut size and dark brown color from the trees nearest the site as compared to nuts picked in the same canyon but away from the impacted area (the browner the color, the more viable the nut, indicating that every nut had nut meat in it . . . grey/white ones have no nut meat, just shell) (see figure 6—1st Canyon #1; and figure 7—1st Canyon #2).

My reason for sharing these two demonstrations with you is to first show you a couple of real life examples of the application of the principles mentioned earlier and then to point out that they were done 25 years ago—this is not new knowledge. In the intervening 25 years, some form of these two intensive carbon applications have been used and demonstrated worldwide on degradated lands of all types.

You should also know that after we got the first year's monitoring data we 'danced' to the USFS and BLM, beginning in Nevada and ending here in DC, saying LOOK LOOK LOOK, let's DO this!!—and at every level we got mild interest, frowns and a new ration of rules and regs to keep THAT from happening again on public land!

I am reminded of an experience I had some 7 years later in Somalia where one of my consulting partners and I had spent several trips over several months to a village (Buran) to help them learn how to apply these principles to regenerate the commonly used valley they depended upon to feed their livestock (another whole story). We had had our lessons and our field trips and our late night discussions and had put together the Holistic plan of action and were finally ready to implement. They had decided we should start by building some small check dams on the sides of a very steep, bare, rocky and eroding hill feeding into this valley.

With everything in place and just before we left the classroom, I looked at the villagers and asked them who we now needed to go ask if we could proceed. After a long silence, one of the old men asked, "Mrs. Tommie Martin, is this good for the land?" "Yes", I said. "Is it good for the animals?" "Oh, yes." "Is it good for the people?" "Yes." "Is it good for the village?" "Yes." And then he asked, "In your country would you still have to ask someone for permission?" And I said, "Oh, yes! And 99 times out of 100 the answer would be 'NO'." After another long pause, the old man asked, "Mrs. Tommie Martin, what kind of a country do you live in?"

GILA COUNTY EXAMPLES

Now to Gila County and our up-close and personal unhealthy forest challenges. Since 2004, I have represented the citizens of District One on the Gila County Board of Supervisors. Gila County, Arizona, located in the center of Arizona just northeast of Phoenix, is a rural county with a population of 53,144, of which 12 percent are unemployed and 21 percent are living at or below 200 percent of the Federal poverty level. Within the County's boundaries of 4,795.74 square miles, there is the Tonto National Forest with seven federally designated wilderness areas totaling 920 square miles and one Wild and Scenic River (the Verde), and three Federal Indian Reservations (Tonto Apache, San Carlos Apache and White Mountain Apache), all of which total about 96 percent of the County's total land base.

Gila County's landscape runs the gamut from Saguaro desert vistas to Ponderosa Pine covered mountains. The elevation ranges from 2,123 feet at Roosevelt Dam to 7,920 feet in its north at both Promontory Point and Myrtle Point, on the edge of the Mogollon Rim. Over one half of Gila County is Federal public land, managed by the U.S. Forest Service. The San Carlos, Tonto, and White Mountain Apache Nations encompass an additional 37 percent of the land within the county.

The Gila County government operates under the economic constraint that 96 percent of the land in Gila County is outside of our tax base as Federal and tribal land. These lands are under Federal and tribal management and exempt from local taxation. Of the remaining 4 percent of the land base, 2.5 percent is property used for mine tailings and taxed at a significant reduction. *We operate on a tax base of only 1.5 percent of the land.*

Of the 1.5 percent, the 1 percent lies in the desert and rangelands of the southern part of the county and the ½ percent lies in the northern forested section. *The heavily forested northern ½ percent represents up to 70 percent of the county's total assessed valuation and is 100 percent at risk from catastrophic wildfire.* In a bit, I will discuss how we as a County have been involved since 2006 in mitigating this risk.

In Gila County, we recognize and understand the importance of protecting our natural resources while providing access for multi-cultural activities, access and recreation opportunities to the public, as well as access to those whose livelihoods depend on resources located on Federal land. Historically, our economy and our residents have depended heavily on both resource-based industries and recreation opportunities on Federal land. We appreciate that we must take care of the land, but we need to be able to use the land to take care of ourselves. Over-protective Federal land policies have created an unsustainable environment for our western culture and economy.

Not only must we deal with the steep challenge of managing a wide range of local governmental needs on such a limited tax base, we must also deal with the complications presented by the land management decisions made by our Federal land management agency neighbors. For example, the risk to our citizens from wildfire grows annually. While we work closely with the U.S. Forest Service to better manage the resource under their control, we are severely constrained in our ability to influence outcomes.

When my ancestors came to Gila County in the later part of the 1800s, the now densely forested lands were described to me by my great-grandmother as "open, rolling, grassy hillsides with stringers of trees in the upper elevations and stringers of chaparral in the lower climes. She drove the wagon that her family came to the area in and said that she could take that wagon in any direction and the boys could run a horse in any direction in what she talked about as a "pine savannah". Never once did she describe it as a forest—she said there may have been 30 trees to the acre in the most forested areas (we now have up to 3,000 in the same area she was describing). (see figure 8—80 years of change)

The streams were perennial and full of a native brown trout (since my grandfather's day we have lost over 1,000 miles of these same streams) and the forest was full of now long-gone birds and wild animals like wild canaries, grizzly bear and wolf.

My family homesteaded and ran free-range livestock on the homestead permit, they owned a sawmill and logged and they prospected and located mines. Once the United States Forest Service (USFS) was established, we ranched on leased Federal lands, all the while bringing cattle, goats, and pigs to eat the understory and grasses and naturally till the soils. The animals constantly moved to maximize the grazing and avoid stressing any one area, because the pioneers, with their nomadic style of livestock handling, knew intuitively that overgrazing was caused by time and not animal numbers.

Finally there is researched science to support this approach, but back then it was common sense. They understood that they needed the land to support them, and they had to take care of the land. Lightning strikes caused fires in the summer when the land was drier than during the wetter winters, but because the animals—wild and domesticated—grazed the land and reduced the potential fuel for the fires, the forest fires were not the deadly threat they are today. In fact, such fires served to maintain the forest ecosystem.

With the advent of the USFS came two of their dictates that became particularly devastating to our dry forests and rangelands (as opposed to the wet forests and rangelands of the eastern seaboard and the western peninsula of the United States, and much of Europe)—a situation they neither recognized nor understood. They both stopped an historic, almost ever-present fire within the forested areas and then they fenced up the open land stopping the nomadic livestock use of the browse and grasses that mimicked the historic use by wildlife. They also changed the wildlife free-range with these fences and have devastated whole wildlife herds through time.

And so began 100 years of rule upon rule, policy upon policy (that continues to this day) to make these initial dictates "work" in an environment that has and will continue to die because of them. We are seeing the end game in our forests now, in fact.

And over time, our ability to use the Federal lands to support our families became severely limited. Logging, mining, and grazing on Federal lands in Gila County has been all but completely eliminated. Environmental regulations and lawsuits created a business environment that shut down the industries that supported our families for generations.

In the name of "science," the logging mills are gone—that is both the infrastructure and the capability. As the Federal leases for grazing were eliminated or severely curtailed, families that ranched for generations lost their herds and their livelihoods and sold out to folks that could afford a ranch for a lifestyle and did not have to depend upon them for a livelihood.

As the forests were allowed to grow unchecked, streams dried up and the water table was taxed due to 100 times as many "straws" taking up water—an acre with 30 trees vs. an acre with up to 3,000 trees turns every little dry spell into a drought. The drier conditions, and the artificial droughts, stressed the dense forest and laid the trees open to pests and disease.

And the wildfire fuel buildup is unprecedented. The threat we live in—virtually a sea of gasoline—is unfathomable and completely created by 100 years of failed Federal policy. The stress on the ecosystem by this burden created by Federal land management decisions over the last 10 decades, now compounded by a warming climate, must be addressed. We must start to restore our western landscapes for their own sake—for their health, functioning and productivity.

But we must also restore them because they ARE our Nation's basic wealth source—and our ONLY renewable wealth source. Managing renewable natural resources should NOT cost our Nation money—it should in fact make money for our Nation. Managing them as our Federal Government now does in fact squanders our basic wealth source—either we do not add wealth to the country's coffers or we outrageously cause cost in areas like 'management', fire suppression and subsidized thinning.

CHALLENGES

As described above, we face many challenges living and surviving in our current environment. These challenges are both environmental and public safety oriented, and economic. In order to meet the challenges posed by a grossly overgrown disease-laden forest, we must look at the environmental and economic causes together.

This land was healthy and thriving not that long ago, and adding to the Nation's treasury through the economy. It can be restored. But the needed restoration will require a major overhaul of Federal land management policy and implementation—again, a shift from a mechanized to a holistic worldview with adaptive management driven by monitoring results.

The following is a short list of the major reasons I see for the serious decline in our forests' health and the related health of the communities dependent on the forests for their livelihood:

- A halting of timber sales, and the related reduced payments to the counties of 25 percent of the value of the sales. The timber sales put people to work and helped support our local governments.
- Insufficient funding for thinning, combined with no timbering, allows chronic overgrowth and buildup of wildland fire fuel that presents a terrifying threat to our county's residents.
- Hijacked use of the National Environmental Policy Act (NEPA) requirements to delay needed thinning efforts and the return of industry. We have been witness to the Forest Service and the environmental groups battling over tree diameters while we burn. This cannot continue.
- Entrenched bureaucracy limits the flexibility needed to reach the creative solutions our landscape requires. The willingness to work collaboratively that is so uniformly and positively discussed in Washington needs to be effectively implemented in the field.

I would like to note for the record, however, that over the years I have had the opportunity to work with many agency people who "get it." They know what the right things to do are and want to do them. But if they try it can affect their careers. Some act very courageously. There are some good people in these agencies, but the "institutional culture" too often dictates unwise and unscientific policies. The result is the kinds of negative consequences I have outlined.

Opportunities

While the challenges are steep, there are a number of positive movements that can help guide more effective Federal land management and best practices of local governments. Here are a few examples:

- Collaboration is critical to restore forest health. We cannot afford to keep fighting about who has the right approach. My worldwide, multi-cultural experiences and my involvement with both 4–FRI and the Forest Service's Collaboration Cadre has shown me that we can save time and money in making land management decisions with all parties around the table from the beginning of the process to the end having an open and respectful dialog.
- Stewardship contracts can allow the forests to pay for their own restoration. This is an effective mechanism to put the forests back to work. To best implement stewardship, I believe that the contracts must be self-sustaining, that is, not dependent on Federal or state subsidies to make the business work. From my experience working around the White Mountain Stewardship contract, as well as 4–FRI, the Forest Service must cultivate and ultimately chose self-sustaining businesses to contract with, but I am not sure the Forest Service has the expertise to evaluate business viability. I recommend that Congress require that the Forest Service evaluate—or cause to be evaluated by a qualified entity, in an open manner, the economic health of the potential contractors, as well as that of their proposals.
- Continue to include cellulosic targets in EPA biofuel standards. On Forests like the Tonto, where there is little high quality lumber, but lots of "fuel," the option of turning the growth thinned from the Forest for biofuels is very attractive. Recently, attention is turning toward creating an economically viable cellulosic ethanol process. As in all developing industries, Federal targets help create a market. If a cellulosic biofuel market can be developed, the Tonto Forest's thinning program could become self-sufficient.

GILA COUNTY'S RESPONSE TO CATASTROPHIC WILDFIRE

Finally, let's visit about Gila County's response to having 70 percent of its assessed value being 100 percent vulnerable to wildfire—

The geographical area known as Arizona's "Rim Country", which is northern Gila County, has experienced several massive and destructive forest fires over the years—beginning with the 25,000 acre Dude Fire in 1990—which at the time was the Nation's first 'mega-fire'. While the Yellowstone Fires of 1988 burned far more acres, the Dude, because of its size, because 6 firefighters were killed fighting it, because it burned 60 homes and because it displayed examples of extreme fire behavior ever witnessed, was considered a mega-fire.

Add to that the 467,000-acre Rodeo-Chediski Fire of 2002, the 119,500-acre Willow Fire of 2004, the 243,950-acre Cave Creek Complex Fire of 2005 and the 538,000 acres of the Wallow Fire of 2011 and you might have a sense of the impending doom we feel as we sit in some of the only remaining, but highly fire-vulnerable, belt of forest along the Rim.

And so, following the 4,000+ acre, $3 million, "February Fire of 2006" north of Payson, AZ (the earliest major fire in that area's known history), I approached the local Ranger District of the U.S. Forest Service to see if there was any way the County could help mitigate what was shaping up to be the area's worst fire season up to then. Then and now, the USFS has no resources for first-strike response. Only after a fire gets to a certain level of involvement can they bring the Nation's resources to bear.

The Forest Service suggested the best help Gila County could give would be to figure out how to locate or provide "enough sources of adequate water that are helicopter-available for first strike resources so that all small fires can become non-fires and all medium fires can be held in place long enough for additional fire fighting resources to arrive."

To make a long story short, Gila County used what we call our "redneck ingenuity". Our Public Works Department bought 20,000 and 50,000 gallon fuel bladders from Desert Storm military surplus. We had about 80 feet of surplus 10-foot diameter culvert which we then cut into 10-foot lengths, plumbed with a 3-inch pipe and drain plug, welded on a steel bottom, hose-clamped used 3-inch hard plastic pipe around the top (to protect helicopter buckets and snorkels) and produced what we call a "Hick's tank" that holds another 6,000 gallons of helicopter-available water. We bought five 11-horsepower Honda pumps and several hundred feet of 4″ soft hose to connect the bladder to the tank. (see figure 9—Tank)

The various local Fire District Chiefs then took on the responsibility of "manning" the bladder-tank set-ups in each of their Districts to make sure the pumps were hooked-up, the bladders and tanks stayed full for initial helicopter use, and the County notified when more water was needed. The USFS committed at least one type-2 helicopter to be available at the Payson Airport all fire season (there are usually several).

We use our County 12,000 gallon construction-water-tank to draft and hold water from creek locations designated by the USFS as water suitable for fire fighting. We then use our 4,000 gallon water trucks to haul the water and fill both the bladders and Tanks so that there is +/- 26,000 gallons total of helicopter-available water in multiple locations. The idea is to have any spot in the Rim Country within about a 5 minute helicopter turn-around water haul (the initial 10 locations have grown to become 44 with most areas being within a 1-minute water turn-around). (see figure 10—Dip Sites)

These set-ups are located behind locked gates and are signed "Wildfire Protection Water—Do Not Disturb. Our ability to help protect your safety depends upon your helping us protect the safety of this water source." The Sheriff's Posse makes regular rounds to check on them.

When all was said and done, the 25 set-ups have cost us right at $750,000 from our General Fund (property tax dollars from that very limited pool of 1½ percent private land in our County) and we spent another $250,000 of those same dollars to match 5 local communities in establishing a fuel break on their prevailing wind southwest sides for fire defensible space. While not completely protected from the tinderbox that our surrounding forest has become after 100 years of failed Federal policy, our communities now do have a fighting chance of battling and surviving a forest fire. And we hope the odds of this County losing 70 percent of its assessed value in one fire are substantially lessened for now.

We also hope that we have bought enough time for Industry to come back into play and let the products of the forest pay for its restoration. Again, we DO NOT have enough money in the Treasury to solve this problem—but we do have enough money in the Economy. We MUST figure out how to use the Economy to pay for this restoration while also providing the environmental goals of a sustainably healthy, productive and functioning forest.

But I digress—since initial placement in 2006, the dip tanks have been used hundreds (probably thousands) of times by helicopters extracting water to fight fires. (see figure 11—C Creek Fire; and figure 11—Poco Fire)

One of our success stories happened on June 20, 2010. That was the same day the Schultz Fire started in Flagstaff. With the same fuel loads and the same weather conditions and within the same hour the Shultz Fire started—a fire began near Kohl's Ranch. Helicopters dipped out of a bladder-tank system placed just weeks before at the Zane Grey site. That fire was held to 4 scorched acres while the Schultz Fire burned 15,000 acres, has caused extensive flooding each rainy season and has caused at least one death.

We now have dozens of these stories—each year our 'fire-water system' is used to put out hundreds of fires. Our most recent success was the Poco Fire north of Young in the summer of 2012. By their own admission, the USFS predicted they had another 500,000 acre fire on their hands due to terrain, fuel load, weather conditions and time of year. Again, by their own admission the fact that they were able to hold it to +/- 30,000 acres was due entirely to Gila County's fire-water set-up and its commitment to minimize every fire.

Eventually, I believe minimized fire danger needs to be accomplished with what is called "environmental economics" whereby the clean-up of the forest pays for the restoration and minimizes the overall fire danger. This leads into discussions about social, economic and environmental sustainability (or the "triple bottom line"), biomass industries, economic development, and so on. This is where the Four Forest Restoration Initiative (4–FRI) comes in—and needs to succeed eventually.

But for now, our bottom line is that we have experienced over 100 fire-starts each fire season since 2006. Eighteen of them were classified "catastrophic potential" by the USFS. One of them burned 150 acres up the face of the Mogollon Rim before it was put out. One became the 800 acre Water Wheel Fire when a local fire helicopter was reassigned to a fire in Texas. The Poco grew and was held at +/- 30,000 acres. ALL of the rest were held to 15 acres or less. There have now been thousands of helicopter water dips taken out of these tanks.

Gila County's current thrust is to continue to try to bring biomass industry to our area to profitably and sustainably clean out the forested area so as to restore and maintain our forest's health, functioning and abundant productivity. We know that what we have done with our bladder-tank and fire-break efforts is a brief stop gap that will either need to be expensively re-done and maintained continually or engage industry to profitably do so.

We also know that, long term, there is not enough money in the pockets of the local citizenry to solve this problem, either—but that there is most certainly enough money in forest products for industry to do so. It is past time to stop being so willing to let our forests and watersheds catastrophically burn, and start being willing to let them earn. (see figure 12—Smokey burning)

We are happy to share our data, pictures, ideas and personal stories with anyone interested in this type of cooperative, first-strike response, catastrophic fire prevention.

In summary, Mr. Chairman, let me speak directly to the issue being considered in these hearings. There is immense potential to sequester vast amounts of carbon in the soils of the public grasslands and the public forest lands. Acting to increase carbon sequestration on forest lands increases a double carbon benefit. By improving forest health through the steps I have outlined here, we make it less likely that fires will occur, especially mega-fires. That means that the carbon currently locked away in the forests will not be released in these fires. At the same time, these healthier forests would also sequester much more carbon in the soil.

One of my business partners maintains that Paradise is not lost, it is merely disassembled . . . and the pieces are lying around in plain sight. This testimony points out many of those pieces. Another partner claims "if it is to be, it is up to me!" In this case, if these pieces are able to be reassembled, it will have to be with the help of Congress.

Again, thank you for the invitation to present this information to you.

Figures submitted with statement are available on the Committee's Web site and are also being retained in the Committee's official files.

ADDITIONAL TESTIMONY OF TOMMIE CLINE MARTIN, SUBMITTED FOR THE RECORD

INTRODUCTION

The following case study provides an example of the concern raised during this hearing about the limitations of existing Federal regulations and the resistance of many Federal land managers to permit the kinds of proven livestock management techniques that would sequester vast amounts of carbon in the soils of public lands and forests and restore ecosystem health at the same time. Further, it provides an example of why I and others think that it will require action by the Congress to bring about the kind of changes in philosophy, regulations and management approaches to accomplish these two objectives.

Under present Federal regulations, optimal control of time, intensity and frequency of grazing events cannot be achieved to the degree required to accelerate carbon sequestration-based restoration of soils and other ecological values.

In the past, various highly successful efforts to use optimum methods on these lands were attempted by ranchers. These highly capable families voluntarily gave up decisionmaking control of their public lands ranching operations (and so, a large degree of control over their personal finances and futures) to collaborative teams of local environmentalists, local citizens, university and agency wildlife, livestock, archeology, etc. specialists and scientists, state wildlife department personnel, etc. The teams had authority—under district approval—to set herd stocking rates, seasons of use, etc.—or to suspend grazing use if data indicated that was necessary to maintain the health of the range.

Federal regulations required that the regular grazing permits of these ranchers be set aside. Grazing operations—of legal necessity—continued only under scientific, ecological restoration, etc. "Livestock Use Permits", memorandums of understanding (MOUs) and other instruments were employed. These collaborative teams consistently got excellent environmental results and should have been praised, thanked, and imitated. Instead, most were harassed and discouraged.

The history of Tony and Jerrie Tipton (Jerrie is now a county commissioner) of Mina, Nevada is a documented case in point. This couple were and are self-sacrificing, innovative, highly idealistic, energetic, scientifically trained, highly capable, responsible, and motivated ranchers who care about the land. Federal and state employees, in addition to their official duties, along with other team members, gave up weekends to do frequent scientific monitoring necessary to guide decisions and familiarize numerous people with monitoring methods.

As this case study shows, there is a growing subculture within the Federal management agencies which is emotionally invested in and committed to an anti-livestock agenda. It was taking root even at the beginning of the time period covered by this case study. The Federal agency personnel—including those at the district level and above—were well aware at the time that they took severe career risks in supporting these efforts but they did so because they could see the improvements on the ground and they were dedicated to rescuing nature. Presently, this anti-grazing ideology is pervasive in the management agencies.

Jerrie Tipton is my sister and I am a firsthand witness to the events described here. The committee needs to understand what is happening on the ground and how, unless changes are made, it will make increasing carbon sequestration on the public lands more difficult or impossible.

TOMMIE CLINE MARTIN,
Supervisor, Gila County, AZ.

THE TIPTON'S STORY AND TIMELINE

In 1988 Tony Tipton entered into a lease purchase agreement with Jim Champie for the Carter Ranch and associated USFS and BLM grazing allotments located west of the town of Austin, NV in the Reese River Valley. The grazing allotments began adjacent to the south side of the town of Austin and continued along the crest of the Toiyabe Range south to Big Creek, and west to the Carter Ranch private land.

Tony had begun to attempt to manage his livestock and land(s) to improve forage and habitat. He began that process by inviting other livestock permittees, wildlife folks, agency personnel, environmental folks, and general public to get their input into what the natural resources needed to become more healthy, functioning, productive and sustainable. This group morphed into the Management Team.

In 1989 Tony and Jerrie Tipton and the 'Management Team' approached Vic Castner, mine manager at the FMC Austin Gold Venture mine near Austin, NV, with a proposal to reclaim the Cyanide/acid leach pond face, using livestock. The agreement was that the mine would cover the cost of the hay for the livestock and supply the approved seed mix and Tipton's would spread the hay and seed and feed the animals. IF anything grew and the mine could recover their reclamation bond, after 3 years, then Tipton's would receive some other funds for their work.

Tipton's walked and seeded by hand, and they and the Team spread hay on the face of the dam and fed cattle over a 5-day period between October 23–October 28, 1989. 350 head of cows with calves were fed about 3 ton of hay (organic meadow grass, alfalfa and wheat grown locally) to the acre (32 ton total). They fed enough hay to cover the animals' nutritional needs and put at least a ton of mulch per acre into the soil for the soil bugs—and had outstanding success. In the first year the 10+ acre site produced 6,800 pounds of dry, perennial matter per acre (3.4 tons/acre), on 6.25 inches of annual moisture. The elevation of this first reclamation site was 6,400 ft.

The success on the mine site, and in other locations (Porter Canyon, First Canyon and the Indian Canyon area), enabled the local U.S. Forest Service personnel to create a Memorandum of Understanding (MOU) between the Tipton's, the Management Team and the USFS to allow other restoration processes to proceed on the rest of the Carter Ranch Allotment.

In 1991 the Tipton's and the Management Team entered into a MOU with the Forest Service to do just that. Over the next 6 years, the Tipton's and the Management Team restored numerous areas on the allotment using minerals, water and mixed classes and kinds of livestock, and occasionally brought in feed to concentrate and control the animals.

In 1990 the Team directed the use of 350 head of Tipton cattle and 350 head of non-owned cattle to do the restoration work. In 1991 they had the 350 head of Tipton cows and calves and 1,800 head of Holstein dairy herd replacement heifers.

Also in 1990, Tiptons purchased 1,800 head of weaned, wether meat goats and ran them with the cattle to have a diversity of 'grazers/browsers' to encourage plant species diversification in targeting the wildlife habitat goals of the Team. In 1991 they sold the wethers and purchased 450 head of first kid nannies which they ran with the animals on the Austin Allotments for 2 years. In the spring/summer of 1992 they had their 350 head of cows and calves and about 900 head of one of the neighbor's cows and calves.

In 1992 they purchased the BLM Cedar Mountain Allotment near Mina, NV in the Carson City District BLM to winter the livestock and only use the Austin allotment/private land for late spring, summer and early fall use. In the fall of 1992 they had 350 head and another 300 head of non-owned livestock.

The success on the Austin mine site also caught the attention of the mining industry. This type of mine reclamation had never been tried before, but the mining industry—following the dictates of economic principles—quickly understood that the process was very, very inexpensive as compared to any conventional approach. They also saw, helped measure and understood why the reclamation results were more successful and more permanent than conventional and expensive hydro mulch they had been using because the soil had been fed in a way that it could sustain the vegetative cover for years.

The Tiptons completed a second mine reclamation project, using that 650 head of cattle, during the months of September thru November 1992 at the Western States Minerals Northumberland Mine located east of Carvers in Smokey Valley, NV (near Round Mountain Mine). The mine was located at about 9,000 feet in elevation and they worked on about 300 acres total within the mine site—on closed roads, a lay down yard, a leach pad, etc.

While the Tiptons were not as impressed with the results of this second mine site as they were with the site at Austin, nevertheless, the USFS was impressed and 2 years after it was completed, the mining company received an award from the USFS for the outstanding reclamation.

After completing that reclamation job they trailed the animals from the mine site to the RO Ranch headquarters in Smokey Valley and trucked the animals from there to the Cedar Mountain Allotment.

Prior to placing any livestock on the BLM Cedar Mountain Allotment, the Team had set up numerous monitoring transect sites and clipped and weighed previous year's vegetation production. The average annual production of forage on that allotment was just shy of 10 lbs/acre with average annual moisture of 4″.

In 1988 the Natural Resource Conservation Service (NRCS—formerly the Soil Conservation Service) had completed, compiled and printed the soil studies of all the BLM administered lands in Mineral County including these allotments. The NRCS soils books indicated that the Cedar Mountain Allotment, on an average moisture year, should have been producing between 300 and 400 pounds of dry native perennial grass/acre and 250 to 350 pounds of dry perennial shrubs/acre. A far cry from the almost 10 lbs/acre it produced.

Upon the purchase of the Cedar Mountain Allotment near Mina, the Management Team expanded to include Carson City BLM personnel along with the Battle Mountain District BLM folks and the Austin USFS Ranger District folks.

Until the fall of 1996, the Tiptons continued to use the Mina Allotment in the fall, winter and early spring, and would either trail or truck the animals the 125+ miles to the Austin Allotments for late spring, summer and early fall. Then they would either trail or truck the animals back to the Mina Allotment in the fall.

In the summer of 1996 the USFS informed Tipton's and the Management Team that they would not renew the MOU which allowed for the restoration projects to continue on the Austin USFS Allotment. **Not** because they were not achieving the desired results but because what they were doing was too 'controversial' in the state office and with the other livestock permittees in the Austin area.

And with the loss of the MOU, the Tipton's would have to return to the dictates of the term grazing permit (which had been placed in a non-use status while the restoration projects were occurring). These dictates were for about 300 head of cows and calves spring, summer and fall use, and continue to winter in the Mina country for 5 to 6 months—so a return to about ¼ the numbers of cattle, and no mixed livestock at all—and only for part of each year.

Knowing that mixed livestock and larger numbers of animals using forage for shorter periods of time was a key in restoring the soil health and vegetation, the Team knew that by reducing the numbers of animals, and using the land for longer periods of time, they could not continue to move their environmental goals forward.

After much discussion with the Management Team members and the Carson City BLM personnel, Tipton's made the decision to move the restoration efforts to the Mina Allotment. Tipton's did not continue the lease option on the Carter ranch and allotments and moved the operation to Mina (as an aside, Tipton's and others involved, paid out close to 1 million dollars on restoration projects in the Austin area over the years of 1989 thru the fall of 1996 that they had to leave behind).

(One of the most interesting results on the Austin USFS permit was what occurred between the mouth of Veach Canyon north to the Austin Town limits. In the late 1960s the USFS spent quite a bit of range improvement money and had drilled and seeded rows and rows of a crested wheat grass monoculture on the alluvial fan lands and rolling foothills between Veach Canyon and Austin. When Tiptons began using more numbers of livestock, other classes of livestock and different seasons of use in 1990, within 5 years the original rows of crested wheat plants had all but disappeared from view. The interspacing's were being filled with highly diverse native perennial grasses, forbs and brush without any seeds having been added. The appearance of a drill-rowed seeding disappeared.

USFS Ranger for the Austin District, John Kenslo, retired to Austin and when the native species began to take over the introduced wheat grass seedings, Mr. Kenslo took the then current Ranger to task for allowing Tiptons to 'ruin that crested wheat grass seeding'. Retired USFS Ranger Kenslo didn't like it . . . but the wildlife did! But that's another story. Over 50 percent of the forage produced in the old seeding, to this day, is a native, perennial grass/forb/shrub mix.)

Carson City BLM personnel had been favorably impressed with the land, water and wildlife habitat improvements which had occurred on both the Austin and Mina BLM Allotments due to the restoration efforts and began to generate a similar environmental assessment (EA) document to formally allow the same processes to happen on the allotment near Mina. In addition, an allotment south and west of Mina, the east half of the Belleville Allotment, had recently been vacated from non-use and the Carson City BLM began the process to have that allotment given to Tipton's to expand the land base for restoration.

The Cedar Mountain/Belleville Restoration Environmental Assessment (EA) was signed by the BLM, the not-for-profit group Twenty to One (which was formed in 1993 to do the actual restoration projects), the Tipton's and the Mina Management Team in February of 1997.

The Team and Twenty to One had had livestock (1,000+ head: 350 cows and calves, remainder was yearling heifers and steers) on the east portion of the Belleville Allotment beginning in October of 1995 through August of 1996 and had moved them to the Cedar Mountain Allotment to complete a watershed restoration project in the Douglas Basin watershed which had been funded by Nevada Department of Environmental Protection (NDEP) and National Fish and Wildlife Foundation (NFWF) and Twenty to One.

While there, the group did a seeding trial on the National Burro Refuge at Teel's Marsh. The BLM had purchased seed and hay and, over a 40-hour period, the Team seeded and fed the animals at different rates in an enclosed area. This occurred on the 17th and 18th of July, 1996 and became another monitoring site. The Team had been asked by the BLM to do this so they would have some data relating to restoration within the refuge for a future project. This BLM seeding trial, as it was called, within 1 year had between 12 percent and up to 92 percent establishment of native perennial grass, forb and brush seedlings, depending on the feeding and seeding rate.

After completion of the watershed project in December of 1996 the livestock were moved to the Kinross Mining Company's Candaleria Mine for a reclamation project. This site is surrounded by the eastern half of the Belleville Allotment. The plan was to use the livestock to reclaim a 750 foot high waste rock dump and a 3 acre corner of the original cyanide leach pad.

(The monitoring in 1998 on the Candaleria Mine site included: 1,800 pounds of dry, perennial matter/acre grew on less than 4 inches of annual moisture; total and active bacteria component within the soil profile had started at 28 milligrams per gram of soil prior to the reclamation and one year later was at 480 milligrams per gram of soil, with and added 12 milligrams per gram of fungal component; on the cyanide leach pad the sodium absorption ratio (SAR) had, within 3 years changed from 200–400 ppm to 3–5 ppm.)

The project lasted through May 1997 and the plan was to then continue on with reclamation projects within the Belleville Allotment. As they got ready to move the livestock from the Mine to these Belleville projects, the BLM informed the Tipton's that because the other permittee in the Belleville Allotment was currently in a court case with the BLM they did not want the Tiptons to use the rest of the Allotment until that case was settled. The Tiptons had to make other arrangements for the 900 head of livestock that they did not own and paid to put their 300+ head on pasture until they could move back to the Cedar Mountain Allotment in the fall.

The Tiptons were never allowed by the BLM to return to the Belleville Allotment. The paperwork to transfer the eastern portion of the Belleville Allotment to Tipton's never was completed, although annually they would request to be granted the vacant portion of the Allotment.

(Just an FYI—On just one of the monitoring transect sites on the Belleville Allotment, data was collected before any treatments in March of 1993 by Rich Benson (BLM), Earl McKinney (BLM), Les Boyd (local resident), Brian Bill (Yomba Shoshone tribal member) and Jerrie Tipton. The average distance between perennial plants was 16.15″ with 93 percent total bare ground, overall. Then data collected in June 1995, just 2 years of concentrated livestock 'jump starting' the carbon cycle, data showed bare ground had reduced to 90 percent with an average distance between perennials of 5.35″ and 51 percent of the perennials were native grass seedlings.

After the BLM forced the removal of livestock from the area in 1996, the June 2004 data—11 years after the initial data was collected—showed a quick slide back to 94 percent bare ground with an average distance between perennials of 15.35″. Ten years after that, by July of 2013, the data was recording 19.5″ of bare ground between perennial plants. A perfect example of the results of little to no carbon cycling nor carbon stored in the ground; followed by the rapid response of intentional carbon cycling and storage; and then how quickly stopping carbon cycling expresses itself as ever increasing bare ground—or desertification.)

In the late summer of 1998 the Tiptons were asked to do another mine reclamation job for Kinross Mining at their Sleeper Mine north of Winnemucca, NV. The open pit had one wall that was mostly sand and as the pit began to fill with water the mine could not get anything to grow on the sandy slopes. In late November and December of 1998 they used a local rancher's livestock, the mine bought the hay and seed and the Tiptons fed the cattle on the mine.

By the winter of 1998 most of the original BLM members on the Management Team had either retired or transferred to other places and the individuals that took their place were strongly against using livestock for restoration. The Team was in the middle of another restoration project on Cedar Mountain Allotment when they were told they could not use more than 200 to 300 head and could only use the Allotment in the winter months. So once again the Tiptons had to pay to put the animals on pasture the summer of 1999, 2000, and 2001.

In 2005 the last remaining BLM employee member of the Management Team, Rich Benson, died of a heart attack and, not only had the BLM institutional memory of the entire project been lost, but for some reason the monitoring data and hundreds of photos which had been Team collected annually and copies kept in the BLM files . . . **disappeared**. When some of the Management Team members offered to share copies with the BLM they were told that "it is not BLM data and we would not use it to make any decisions anyway."

The BLM continued to maintain that the Cedar Mountain/Belleville EA was not a valid legal EA because it had nothing to do with a livestock grazing permit and if Tiptons continued to put non-owned livestock in the numbers and seasons used, they would be in trespass and loose the grazing permit.

In 2007 the term grazing permit for the BLM Cedar Mountain Allotment was up for renewal. Tiptons and the Management Team tried to get the BLM to use the then 10–13 years of monitoring data in the analysis for the renewal. Once again the response was "it is not BLM data and we will not use it".

The permit was renewed with a change of 55 percent utilization reduced to 45 percent. Tiptons' maintained that if the allotment was in that bad of condition, then how could the BLM renew it at all and protested the decision. The Tiptons hoped to get the case in front of an Administrative Law Judge (ALJ) and have the previous 15 years of process and results on the record at the very least.

The ALJ determined the Tiptons were not being harmed by the decision, that the BLM had not done anything wrong in making the decision and therefore denied the appeal. They appealed his decision to the Interior Board of Land Appeals (IBLA) and got the same response.

The Tiptons have continued to maintain that the 1997 EA is legal and valid, and since about 2010 they have run cattle year round on the Cedar Mountain Allotment, but never more than the 935 AUMs the allotment is permitted for (about 75 head). Annually, they are threatened with being in trespass but have never received a trespass notice.

In the summer of 2012, Teresa Knutson, the Area Manager of the Stillwater Field Office, BLM Carson City District, met with the Tiptons in Hawthorne, NV. At that meeting, she said they needed to resolve the issue of the 'illegal' EA or she would issue a trespass notice for livestock on the allotment outside the term permit parameters.

By this time they had been running about 75 head year around, to not exceed the 935 AUMs the permit is allowed. The Tiptons once again tried to explain to her that the EA was written outside the term grazing permit because it was for 'restoration' and not 'grazing'. To which she replied "you got screwed, those guys had no authority to give you the EA nor tell you that you could have the eastern portion of the vacant Belleville Allotment, and there are no records in the BLM Carson city office to indicate they were ever going to do that." To which the Tiptons replied "then, issue the trespass".

In March of 2013 they received a letter from Area Manager Knutson that upon review, the EA **WAS** a legal document (15 years after the fact) but the BLM was going to cancel it because the data was no longer valid (see the attached letter). The Tiptons promptly sent the letter to their attorney (Leah Zabel) and her response is also attached.

To date, neither the attorney nor Tony Tipton, as agent for Twenty to One, have received any other correspondence from the BLM about the matter.

(AS AN ASIDE, from 1993 until 2002 the Mina Management Team met regularly in the Carson City BLM conference room to review monitoring, revisit the Team's ecological goals, set the following years management plan, and welcome new members. In the winter of 2002, someone in the BLM decided that this was no longer an appropriate use of their conference room and the Team was told they would no longer be allowed to meet there—that the room was no longer available for permittee meetings but only for government business.

In addition, Management Team members have been told that beginning about 2002, Carson City BLM employees have told anyone who will listen—including the aides of all the Senators and Congressmen from Nevada—that Tony and Jerrie Tipton are the biggest trespassers in their BLM District.

And another footnote, Mike Berry, the most recent range rider and counter of livestock for the Carson City BLM District, recently had to retire due to health reasons. Before he left the office he was told by his superiors to destroy all of his records on the Tipton's and the Holmgren's (a ranch neighbor of the Tiptons) BLM Allotments that he had been responsible for. He did not do this, but instead left all the information stacked on his desk when he left BLM. He would be willing to testify as to who it was that told him to destroy the records.)

Attachments

ATTACHMENT 1

U.S. DEPARTMENT OF THE INTERIOR,
STILLWATER FIELD OFFICE,
MARCH 1, 2013.

Mr. and Mrs. Tipton,
Mina, WV 89422.

Dear Mr. and Mrs. Tipton:

After some BLM misunderstanding in regards to livestock grazing on the C-edir-Mountain Allotment, it is now understood that the 1997 Cedar Mountain Ecosystem Restoration Project EA was approved outside of the grazing permit regulations. The 1997 EA was not intended to alter the grazing permit but to allow the proponent (Twenty to One) more flexibility to restore native vegetation on the Cedar Mountain Allotment.

After further examination by the Stillwater Field Office Interdisciplinary (ID) Team and completion of a determination of NEPA adequacy (DNA) on the 1997 EA, it was concluded that the EA no longer adequately evaluates the restoration project or current range conditions on the Cedar Mountain Allotment. Therefore, the 1997 Cedar Mountain Ecosystem Restoration Project EA and Decision are no longer valid and implementation of any actions for that project is not allowable. To continue with this project, you need to submit a new plan with details on what actions are proposed, who is involved, when the activities would take place, where the activities would take place, and the duration, etc.

The current grazing permit #2703554, which was renewed in 2007, is the only document that authorizes livestock grazing on the Cedar Mountain Allotment. The permitted use for the Cedar Mountain Allotment is 186 cattle from November 1 to March 31 each grazing year, for a total of 925 AUMs. If livestock are observed on the Cedar Mountain Allotment outside of the permitted season of use; you will be out of compliance with your permit and subject to 43 CFR § 4150.1 violations. This could result in civil penalties or criminal sanctions.

If you have any questions, please feel free to contact your Rangeland Management Specialist Chelsy Simerson at 775–885–6019 or me at 775–885–6156.

Sincerely,

TERESA J. KNUTSON,
Manager.

ATTACHMENT 2

ZABEL LAW,
JUNE 11, 2013.

Teresa J. Knutson, Manager,
Bureau of Land Management,
Stillwater Field Office,
Carson City, NY.

Re: March 1, 2013 letter to Twenty to One, NEPA Inadequacy Finding of Cooperative Agreement 4160 (NVC0100) and May 20, 2013 Notice of Unauthorized Use

Dear Ms. Knutson:

This letter is a formal protest on behalf of Twenty to One, a non-profit corporation which is in receipt of the above referenced letters from the Bureau of Land Management's ("BLM"). The March 1, 2013 letter claims that based on a determination of National Environmental Policy Act ("NEPA") adequacy (DNA), the 1997 Cedar Mountain Ecosystem Restoration Project EA ("1997 EA") and Decision are no longer valid and that implementation of any actions for that project is not allowable. BLM's May 20, 2013 Notice of Unauthorized Use directs Twenty to One to cease all restoration activities by removing the instruments of the approved restoration activity (e.g. cattle being used to test and implement soil __ technique). BLM's March 1, 2013 declares the invalidity of the 1997 EA without providing any documentation or demonstration of NEPA compliance. The 1997 Cedar Mountain Ecosystem Restoration Project EA (Cedar Mountain EA) was prepared to comply with the NEPA requirements related to the execution of the February 28, 1997 Twenty to One Cooperative Agreement. Despite the BLM's repeated administrative actions to undermine and abandon the contract, BLM has provided no evidence that the NEPA process for making such a finding was satisfied. At this juncture, BLM' demonstrate nothing other than bad faith in regards to this contract.

Twenty to One raises the following specific issues in our objection:

1. BLM's failure to adhere to the requirement of NEPA;
2. BLM's arbitrary decisionmaking process related to the Cooperative Agreement;
3. BLM's apparent disregard of monitoring data demonstrating achievement of the cooperative agreement's goals.
4. BLM's apparently arbitrary decisionmaking with respect to the cooperative agreement and its rangeland improvement.

Cooperative Agreement

The subject contract was entered into in accordance with the Congressional directive for the Bureau of Land Management, specifically:

> (2) manage, maintain and *improve the condition of the public rangelands* so that they become as productive as feasible for all rangeland values in accordance with management objectives and the land use planning process established pursuant to section 1712 of this title; . . . (italics added). 43 U.S.C.A. § 1901.

The Twenty to One Cooperative Agreement was and is a valid exercise of the BLM's authority. In accordance with NEPA, a valid environmental assessment was conducted. If BLM now feels that the 1997 EA needs to be changed or canceled, BLM must comply with NEPA prior to any modifications of this agreement.

Use of a Determination of Adequacy as a Substitute for Compliance with NEPA

"Under National Environmental Policy Act (NEPA), an agency must prepare a supplemental assessment if the agency makes substantial changes in the proposed action that are relevant to environmental concerns." 42 U.S.C.A. § 4332(2)(C); 40 C.F.R. § 1502.9(c)(1)(i). New Mexico ex rel. *Richardson* v. *Bureau of Land Management*, 565 F.3d 683 (10th Cir. 2009).

BLM's assertion that it has invalidated the 1997 EA thought the use of a DNA is incorrect. "DNAs are an administrative convenience created by the BLM, and are not defined in NEPA or its implementing regulations issued by the Council of Environmental Quality." *S. Utah Wilderness Alliance* v. *Norton*, 457 F. Supp. 2d 1253, 1255 (D. Utah 2006) *aff'd in part, appeal dismissed in part sub nom. S. Utah Wilderness Alliance* v. *Kempthorne*, 525 F.3d 966 (10th Cir. 2008)

Further, the preparation of a DNA does not preclude the necessity of compliance with NEPA. (See *S. Utah Wilderness Alliance* v. *Norton*, 457 F. Supp. 2d 1253, 1261 (D. Utah 2006) *aff'd in part, appeal dismissed in part sub nom. S. Utah Wilderness Alliance* v. *Kempthorne*, 525 F.3d 966 (10th Cir. 2008)).

Other BLM Offices have issued guidance in the form of NEPA handbook that clearly support the use of a DNA only to identify the need for further NEPA analysis.

"A Determination of NEPA Adequacy (DNA) may be used for a proposed action when the following conditions are met: (A) the proposed action is adequately covered by (i.e., is within the scope of and analyzed in) relevant existing analyses, data, and records; and (B) there are no new circumstances, new information, or unanticipated or unanalyzed environmental impacts that warrant new or supplemental analysis . . . (I)f the Responsible Official determines that existing NEPA documents adequately analyze the effects of the proposed action, this determination, prepared in a DNA worksheet provides the administrative record support, and serves as an interim step in the BLM's internal decisionmaking process. The DNA is intended to evaluate the coverage of existing documents and the significance of new information, but does not itself provide NEPA analysis".[1]

Disregard for Scientific Data Supporting Habitat Restoration Activities

On several occasions over the last 10 years Twenty to One has been told (verbally) by the Carson City District Office that the 1997 EA were 'illegal' under the term grazing regulations and therefore could not engage in activities authorized by the 1997 EA. On each of these occasions Twenty to One has clarified that the agreement is not a grazing permit and requested clarification as to the "illegality" of the contract and 1997 EA. In a show of good faith, Twenty to One agreed to a temporary suspension of activities under the contract while attempting to clarify BLM's legal position on the validity or invalidity of the contract. However, BLM clearly acting in bad faith, proposed no solution and now simply deems the contract invalid. During the entire time, Twenty to One has attempted repeatedly to obtain clarification from BLM, however, no amendment or other action has been proposed by BLM.

In fact, the only explanation Twenty to One has been offered by BLM is that the 1997 is "outside" of any term grazing regulations. BLM is simply ignoring the fact that the agreement was intentionally constructed 'outside' of the grazing regulations, which is why it is NOT a grazing permit, but a cooperative agreement. The explicit purpose of the contract between Twenty to One and BLM was in fact the restoration of rangeland. This restatement of a fact that was plain in 1997 and BLM has not provided any clarification as to why this is no longer the case. Thus, Twenty to One is requesting that BLM provide clarification of their objection to the activities outlined in the 1997 EA and undertaken by Twenty to One pursuant to the February 28, 1997 Twenty to One Cooperative Agreement.

As a result of BLM's refusal to abide by the terms of the Twenty to One Cooperative Agreement and to participate, and while Twenty to One was attempting to clarify the BLM's objection, Twenty to One has scaled back its restoration activities. The restoration activities outlined in the 1997 EA were possible through the efforts of different agencies, groups and individuals that were involved in all phases of the project (from goal setting, data collection, compilation and review) included the Twenty to One board members, Nevada Department of Environmental Protection, National Fish and Wildlife Federation, Pat Hannigan (one of the livestock owners) Tipton's (permit holder and livestock owner), Audubon Society, Public Resource Associates, Rocky Mountain Research Station, University of Texas at Austin, and

[1] Bureau of Land Management Utah NEPA Guidebook, July 2009, available at: http://www.blm.gov/pgdata/etc/medialib/blm/ut/st_george_fo/planning.Par.15339.File.dat/Utah_NEPA_Guidebook_July_2009.pdf, last visited June 10, 2013.

bureau of Land Management personnel to name a few. As a result of BLM's failure to meet the terms of the cooperative agreement, those involved have incurred expenses and habitat slotted for restoration has suffered.

The monitoring data the team had gathered and compiled, from baseline data to annual data of the same transects (and have continued to date) clearly showed measurable, repeatable results. Data including decreased bare ground, increased native perennial plant density, increased biological activity both on the soil surface and within the soil profile to increased water storage of the soil. Since 2002 the monitoring data clearly indicates a measurable decrease in plant density, increase in bare ground, decrease in biological activity and a severe decrease in water storage. The original monitoring data also included annual precipitation data, bird species monitoring, numerous photos, riparian function data and water storage data.

Twenty to One supplied the BLM with then current monitoring data in 2007. To date we have not received notice that Carson City/ Stillwater Office staff reviewed or even looked at the data provided. These data demonstrate that Twenty to One created and sustained a healthy, functioning, productive ecosystem under the terms of the agreement. The BLM and its staff by refusing to even review the data provided and through their repeated attempts to abrogate the contractual agreement, have intentionally failed to comply with the terms of the contract in violation of NEPA and have acted in direct opposition to the Congressional charge to, ". . . improve the condition of the public rangelands . . ."

With this letter, Twenty to One is formally requesting the authority for BLM's failure to act in accordance with the terms of the 1997 Cooperative Agreement and 1997 EA. Further, Twenty to One is requesting justification of BLM's actions with respect to the contract. Under FLPMA and NEPA BLM must provide valid documentation supporting their proposed action. This documentation must address the data which supports the effectiveness of activities under the agreement, as well as all NEPA activities, including public notice and comment with respect to their intent to abandon the contract. BLM's breach of the agreement, range conditions have become far from optimum. Further, please clarify the protocol used to determine this and any relevant regulations which BLM cites as authority for its determination. How, when and where was the monitoring done to determine this and who did it?

We take this step of formally requesting this information reluctantly, and only because of BLM's continued intransigence with respect to their contractual obligations. Twenty to One has on numerous occasions, requested this information in formally. The delays, obfuscation, and prevarication on the part of BLM have resulted in great expense to our funders and the habitat restoration projects. Projects have been delayed projects as Twenty to One waited for 'clarification' from BLM. Instead, BLM has continued in its refusal for a prolonged period to provide clarification and as a result, the improvements which resulted from our early efforts under the agreement have suffered. The benefits of the Twenty to One restoration activities were documented and monitored by BLM, BLM has also been provided the restoration activity monitoring data on several occasions. BLM has failed to provide an unbiased evaluation of the monitoring data, relying on scientific method. This failure has resulted in continued degradation of habitat and as a result in a failure on the part of BLM to meet the standards of its congressional directive to improve and maintain rangeland.

Twenty to One asks that BLM immediately withdraw its Notice of Unauthorized Use and provide adequate assurances of its intent to perform its obligations under Cooperative Agreement. Alternatively, if BLM has determined that the existing EA is insufficient, BLM should comply with all NEPA requirements. Should BLM continue to pursue invalidation of the Cooperative Agreement, Twenty to One will seek relief under the Administrative Procedure Act ("APA"), 5 U.S.C. §§701 et seq., and for violation of the National Environmental Policy Act ("NEPA"), 42 U.S.C. §§4321 et seq., and its implementing regulations, 40 C.F.R. §§1500–1508.

Sincerely,

LEAH ZABEL,
Attorney.

Mr. BISHOP. Thank you. I appreciate that.

Mr. Wick.

STATEMENT OF JOHN WICK, CO-FOUNDER, MARIN CARBON PROJECT, PALO ALTO, CALIFORNIA

Mr. WICK. Thank you for convening this important meeting, and inviting me to share our research and experience with soil carbon sequestration on grazed rangelands. My name is John Wick, and I am a rancher from northern California, speaking here today on behalf of the Marin Carbon Project.

As you mentioned, the Marin Carbon Project is a consortium of ranchers and land managers, researchers, extension specialists, non-profits, and local and Federal agencies working together, improving rangeland productivity and sustainability. One way that our group differs from some others is that we work closely with researchers from some of the country's best universities, and we use rigorous science to measure changes in soil carbon for management.

While there are claims of management approaches increasing soil carbon, often these do not turn out to be true when you actually measure the soil. This is a key point, as poor management can have long-lasting detrimental effects on the health and productivity of public lands, and has resulted in soil carbon losses.

Research does show that increasing the carbon content of rangeland soils has many benefits. It improves the drought resistance, decreases erosion, increases forage production. It is also, by the way, better to store carbon in the soils than in the atmosphere, where, apparently, it wreaks havoc on the climate.

I want to start by answering the question, "Can management sequester carbon in rangeland soils?" The answer is yes. Every year I produce more than 50,000 pounds of grass-fed beef on land that was once considered heavily degraded. We restored the productivity of our land by replenishing the soil carbon content.

Under the guidance of Dr. Jeffrey Creque, a rangeland ecologist, and Dr. Whendee Silver, a bio-geochemist from UC Berkeley, I have implemented a management approach that stimulates grass growth. These grasses use carbon from the atmosphere and feed animals that produce food and fiber. Some of the carbon from the plants ends up in the soil, primarily through the production of more root biomass, and can stick around for decades to centuries.

Research by Dr. Silver and her group has shown that rangelands grazed by dairy and beef cattle have had much more carbon when the ranchers applied manure or compost to the soil. In our region we dispose of manure from feed lots and dairies by spreading it as a thin surface dressing on the land. This materials works its way into the soil, and acts as a slow-release fertilizer, growing more grass and increasing soil carbon. Spreading manure, however, has a host of pollution and public health issues. It can also produce a lot of greenhouse gases. If you compost it before you spread it, it is pathogen and weed-free, and it produces a lot less greenhouse gas.

After a one-time, half-inch compost application in 2008 to my ranch, we measured a 50 percent increase in forage production each year for the last 5 years. This is also true for other ranches that were tested. The soil gained an additional ton of carbon per hector each year. This represents over half-a-ton of extra forage, and one-and-a-half tons of captured $CO2$ per acre, per year. Models show that this will likely continue for decades, as the compost slowly continues to break down with all of the co-benefits associated with increased soil carbon, such as including drought resistance and less erosion. Scaled to just 5 percent of California's grasslands each year, this practice would offset all of the state's annual and agricultural forestry emissions.

All of this has been published in peer-reviewed scientific papers over the last 3 years, and those papers will be provided to this committee.

We have now expanded on to several local dairy and beef operations, to further explore the opportunities to scale up this practice. The potential is huge. That scale-up exercise was a USDA-funded NRCS conservation innovation grant-funded exercise. A report from the California Air Resources Board showed that if California, the biggest dairy producer in the United States, were to capture the organic waste stream, it would have enough compost to apply to a quarter of the state's rangelands at regular intervals. We have already created a market protocol for this practice, which is currently being reviewed by the American Carbon Registry, providing land managers an opportunity to participate in carbon trading to help support carbon sequestration in rangeland soils.

In closing, I would like to just repeat that peer-reviewed, rigorous science shows that it is indeed possible to increase soil carbon sequestration on grazed rangelands, and that doing so initiates a cascade of beneficial effects that improve the value of public lands. We have used compost, but there are likely other approaches that work also. It is absolutely critical, however, that we use rigorous science to support our management decisions. This, in turn, will support our public lands, and the livelihoods of those people who depend on them. Thank you.

[The prepared statement of Mr. Wick follows:]

PREPARED STATEMENT OF JOHN WICK, RANCHER, NICASIO, CALIFORNIA

Thank you for convening this important meeting and inviting me to share our research and experience with soil carbon sequestration on grazing lands. My name is John Wick and I am a rancher from northern California, speaking today on behalf of the Marin Carbon Project. The Marin Carbon Project is a consortium of ranchers and land managers, researchers, extension specialists, non-profits, and local and Federal agencies working on improving rangeland productivity and sustainability. One way that our group differs from some others is that we work closely with researchers and extension from some of the country's best universities to take a rigorous scientific approach to measure changes in soil carbon from management. While there are a lot of claims of management approaches increasing soil carbon, many of these do not turn out to be true when you actually measure the soil. This is a key important point, as poor management can have long lasting detrimental effects on the health and productivity of public lands, and has resulted in soil carbon losses (Lal 2004, Bai et al 2008).

Research *does* show that increasing the carbon content of rangeland soils improves the drought resistance, decreases erosion, and increases forage production (Havstad et al. 2007, DeLonge et al. 2014). It also, by the way, is better to store carbon in soils than in the atmosphere where it apparently wreaks havoc with the climate.

I want to start by answering the question: **Can management sequester carbon in rangeland soils? The answer is YES.** Every year I produce more than 50,000 pounds of grass-fed beef on land that was once considered heavily degraded. We restored the productivity of our land by replenishing the soil carbon content. Under the guidance of Dr. Jeffrey Creque, a rangeland ecologist and Dr. Whendee Silver a biogeochemist from UC Berkeley, I have implemented a management approach that stimulates grass growth. Those grasses use carbon from the atmosphere, and feed animals that produce food and fiber. Some of the carbon from the plants ends up in the soil, primarily through the production of more root biomass (Ryals and Silver 2013), and can stick around for decades to centuries (Ryals et al. 2014a). Research by Dr. Silver and her group showed that rangelands grazed by dairy and beef cattle had much more carbon, on average 50 metric tons more per hectare; 22 (US short) tons per acre to one meter depth, when the ranchers applied manure or compost to the soil (Silver et al. 2010). In our region, we dispose of manure from feedlots and dairies by spreading it as a thin surface dressing on the land. The material works its way into the soil and acts as a slow release fertilizer, growing more grass and increasing soil carbon. However, spreading manure can have a host of pollution and public health issues; it can also produce a lot of greenhouse gases (Davidson 2009). If you compost it before you spread it, it is pathogen free, and produces a lot less greenhouse gas.

After a one-time ½-inch compost application in 2008 to my ranch, we have measured a 50 percent increase in forage production for the last 5 years (Ryals and Silver 2013, additional data available upon request). This is also true for other ranches where this was tested. The soil gained an additional ton of carbon per hectare each year (Ryals et al. 2014a). That represents over half a ton of extra forage and one and a half tons of CO2 captured per acre per year.

Models showed that this will likely continue for decades as the compost continues to slowly break down, with all the co-benefits associated with increased soil carbon, including drought resistance and less erosion (Ryals et al. 2014b). Scaled to just 5 percent of California's grasslands each year, this practice would offset all of the state's annual agricultural and forestry emissions (DeLonge et al. 2013). **All of this has been published in peer-reviewed scientific papers over the last 3 years, and those papers will be provided to the committee.**

We have now expanded onto several local dairy and beef operations to further explore the opportunities to scale up this practice. The potential is big. A report to the California Air Resources Board showed that if California, the biggest dairy producer in the United States, were to capture the organic waste stream, it would have enough compost to apply to a quarter of the state's rangelands at regular intervals. We have recently created a market protocol for this practice being review by the American Carbon Registry (provided with supplementary material), providing land managers an opportunity to participate in carbon trading to help support carbon sequestration in rangeland soils.

In closing, I would just repeat that peer-reviewed rigorous science shows that it is indeed possible to increase soil carbon sequestration on grazed lands, and that doing so initiates a cascade of beneficial effects that improves the value of public lands. We have used compost, but there are likely other approaches that work well. It is absolutely critical however, that we use rigorous science to support our management decisions. That will in turn support our public lands and the livelihoods of the people who depend upon them.

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Mr. BISHOP. Thank you. I appreciate you coming great distances and being part of the testimony here. I appreciate the written testimony and the oral testimony. And now we will ask if you will subject yourself to some questions.

Start first with Mr. Grijalva, if you have any questions for the panel.

Mr. GRIJALVA. Thank you, Mr. Chairman. Mr. Wick, the idea that grazing can improve rangeland health and increase the potential for carbon soil sequestration gained attention when Allan Savory gave a TED talk last year. Can you describe your experiences on your ranch, or with the study group, and how it relates to those theories?

Mr. WICK. Was that addressed to me?

Mr. GRIJALVA. Yes. Thank you.

Mr. WICK. How much time do we have?

[Laughter.]

Mr. GRIJALVA. I have 5 minutes, but——

Mr. WICK. This is really important, actually. We started our operation, actually, as wilderness enthusiasts, and we removed the grazing from our system entirely. We were confident that grazing was destructive to the environment. And we watched chaos happen after that. Our ranch became a weed-covered mess.

And it was through a little bit of arm twisting that we decided—well, first of all, we met Dr. Jeff Creque, a rangeland ecologist, who suggested that we could actually reintroduce grazing as a beneficial event in the landscape. And, after a bit of arm twisting, we agreed to bring cattle back in as a management tool to promote native grass. And we did use Allan Savory's plannings for this.

Our objective was to create ground-nesting bird habitat. It was not to put on pounds of gain for the animals, or produce meat or wool, but rather, to create an environmental benefit. And so, we were using cattle as a strategic tool to improve the ecosystem. And after just 3 years, we went from five meadowlarks on our fields to over a hundred. So, clearly, this kind of strategic impact on the landscape—and we were using the Savory method—was clearly making something important happen.

So, anecdotally, we witnessed something profound. That was when we engaged Dr. Silver at UC Berkeley, because we wanted to know, bio-geochemically, what was happening under the soil system. And now—I think Dr. Teague will attest to this—that the grazing impact will take a long time, to see carbon changes. But what we were able to do was to ask the simple question: Can management of any kind improve carbon in the soil system? That was our original idea.

The compost application was simply a thought exercise. Dr. Creque suggested that, if we want to see if management increases soil, we have to see if we can actually just get carbon in the soil. So a simple thought exercise of topically applying compost was amazing, the results that happened from there.

We are expanding now to look at how grazing alone could also do that. We don't have that data yet to support that.

Mr. GRIJALVA. Thank you. Mr. Rich stated that holistic land management, I think in what is referenced also as the biodiversity for a livable climate study about holistic planned grazing, that holistic land management is the only practical solution to climate change, and we have the capability to sequester all manmade carbon emissions.

Your experience, is that statement accurate?

Mr. WICK. My personal experience? So it is an exciting idea. And if we look at the data that we have actually measured physically in the soil, and then run that data through the globally recognized century model, it shows that that carbon income—so just to clarify what is happening here, we put a topical application of compost, and then we discounted the carbon in that compost.

What we are measuring is the effect inside the soil of atmospheric transfer through photosynthesis in—from atmospheric carbon through plants into the soil. And the century model suggests that that single application of compost will have ongoing income of carbon for 30, if not 100, years.

Mr. GRIJALVA. So, other adaptation models, lowering emissions, other things like that, those are all—and this holistic approach is the only solution, those would—those efforts, those other models would cease with the——

Mr. WICK. I would like to—this is a social conversation, and we have a transitional opportunity here. So if we continue on the current path of reducing emissions, which I believe is a good thing, but also recognize that atmospheric CO2 has a tremendous benefit when it is managed as a resource to build plants' bodies out of, and additionally, get it in the soil system, it would be helpful to continue on the path of emission reductions while we are building up the research to support the other half of it.

Mr. GRIJALVA. OK, thank you. Yield back.

Mr. BISHOP. Thank you. Maybe I can follow up on where Mr. Grijalva is going.

Dr. Teague, it is kind of puzzling that there seems to be wide disagreement among researchers, although, given any subject, there is always wide disagreement amongst researchers. But on the potential of sequestration of atmospheric carbon in soils, so your estimate that massive amounts could be sequestered, at least in theory, yet there are other researchers that claim that, though it is possible, the total amount is really small in relation to what is being released in the atmosphere.

So I know you talked about this briefly in your written statement. I would like to see if you could explain this or expound on this one. It is the same question from your perspective, Dr. Teague.

Dr. TEAGUE. I would be glad to. Most research is done in smaller areas that don't approximate the size of what happens in management. That is why I showed those landscapes up there. If you do an experiment on a small area, it doesn't represent continuous grazing over the whole landscape.

So, in a large landscape, cattle graze where they want to, and they select the same areas all the time, and graze them very heavily. That causes an increase in bare ground, it reduces the rooting depth and the productivity of the grasses that are there. The bare ground allows for loss of carbon. The less productivity of the grasses means you are getting less carbon sequestration. If you manage in a manner over your whole ranch, where you moderately graze and you allow adequate recovery, you reverse both of those processes. You cover over bare ground, you allow your plants to produce more. So you result in a net increase in productivity.

I have studied ranches side by side in numerous counties in north Texas. And after 10 years, the fairly poor condition of rangeland has been improved under good management, so that it has fixed three tons per year extra, over and above what the baseline people managing normally are. That is a huge amount.

Mr. BISHOP. OK. So I guess what you are both saying is there, the goal is to get the carbon into the ground. It not only takes the carbon out, but then it produces better results, as far as the vegetation that is there. And you are saying that if you manage it properly, you can do this over a wide variety of land.

Mr. Rich, if I could ask you to talk about those differing assessments, as well?

Mr. RICH. If I can steal Dr. Teague's example, there are different levels of ranching skill. And so you have one level that would be the equivalent of Tiger Woods, or some other pro, and then you have another level that would be the equivalent of somebody playing putt-putt golf and losing their putter. And so, if you measure the results of the putt-putt people, then you get a very low estimate. But if you measure the results of the pros, you get a very different and much higher result.

And so, Dr. Teague and others, who have been making these assessments, are assuming that it is the pros who are doing it. And so, consequently, the achievement—the potential of achieving, sequestering all of the atmospheric carbon since the Industrial Revolution is possible

Dr. TEAGUE. If I could add to that, Mr. Chairman?

Mr. BISHOP. Please.

Dr. TEAGUE. I concentrate on studying what the best ranches are achieving, because we want to know what we can achieve. There is degradation due to ranching all over the place. But the key is to learn how to do it better, so we correct those mistakes and improve it. And that is what we are talking about. The improvements, once you implement them, are huge.

Mr. BISHOP. And we have 400 million acres the Federal Government owns. The opportunity of doing this is kind of wide—I have less than a minute, so let me just throw out to the panel that in the project in California it relies on compost application. Is that a necessary component of a sequestration carbon on public lands? Anyone who would like to deal that—does that have to be there?

Mr. RICH. I think it is a great idea if it can be done, if it can be made to work, financially.

Mr. BISHOP. OK.

Ms. MARTIN. And can I answer that very quickly?

Mr. BISHOP. Supervisor?

Ms. MARTIN. What we did—about 25 years ago, look at the data in the pictures. My sister and brother-in-law and I put 32 ton of hay into 15 acres, punched it in with 600 head of cows. It was all the resources we had for hay. We got 6 inches of moisture that year, some in snowfall, some in rainfall. Off of that sterile ground, we clipped and weighed back three ton to the acre that grew on that sterile soil with those kind of inputs.

We also went up a canyon with that same herd, and we used on-site material. We took into a sagebrush area, broke the sagebrush down, worked it into the ground. The exciting thing there, we had some of those same gains, but the main thing we had is your pinyon nuts—and you have pictures of them—were twice as big——

Mr. BISHOP. OK, I am going to interrupt you here, and we will come back to another round of questions. I will pick up with that, so you can finish the rest of the story.

Ms. MARTIN. You got it.

Mr. BISHOP. But let me turn on to the other Members here.

Whoever wants to go first. Mr. Huffman?

Mr. HUFFMAN. I could. Thank you, Mr. Chair. Fascinating discussion. Thanks again to all the witnesses.

It seems that one common theme I am hearing, both from Mr. Teague, and Mr. Wick, and others, is that nobody here is advocating overgrazing, and high levels of grazing, that there seems to be a consensus that one of the keys to making this work is appropriate rest periods. Mr. Teague, you talk about a rotational paddock system.

So, does anyone disagree here that one key to realizing the impressive potential benefits we are talking about here is appropriate rest periods and making sure that overgrazing is not occurring?

Mr. RICH. I think we all agree.

Mr. WICK. Yes, all agree to that.

Mr. HUFFMAN. Yes, I think that may be one reason why some of our friends in the conservation community have a hard time getting their head around this issue. They are used to battling the impacts of overgrazing. And so, even thinking about potential beneficial effects of proper grazing levels is a leap beyond what they have been involved in. But it is certainly one that you are all taking in a great way.

And, Mr. Wick, you have sort of found that this addition of compost may be the secret sauce to getting an even much higher level of beneficial carbon sequestration effects. Whether it is compost, where that can be done, or the paddock more intensive management system that we heard about from Dr. Teague, all these things are going to require more management by ranchers than the putt-putt golf that perhaps some have been engaged in.

Have any of you begun to think about the cost of that, and how that might be managed? And I guess, specifically, I am wondering if any of you envision a system some day where emitters, perhaps energy utilities, might actually pay to sponsor investments by ranchers in this kind of more intensive management in order to achieve those carbon benefits as offsets for their own emissions.

Mr. WICK. Can I respond to that? So the protocol that we have worked on now in our—in California, actually, would support that kind of interaction between a utility company and a land manager.

And I just wanted to touch on the compost component of this. That is where we have our data. So that is the thing we are strongest about. But we are expanding our research to look at grazing and restoration and other practices, as well. So, we have the data on compost, we have noticed—we have observed that when you do put carbon back in—and it is really important to realize what we are describing is restoring carbon. The soil systems globally are deficient in carbon from historic levels. So compost is simply restoring functional carbon in that system. And then, from there, there are a range of different opportunities to expand on.

Our protocol is modular in design, and as grazing management practices are proven scientifically to sequester carbon, they will be able to be added in on top of or in place of the compost, and this will support carbon markets in California in particular. A utility company could engage with a large land owner or individuals, and negotiate an exchange for those tons of carbon removed from the atmosphere photo-synthetically. They could support that by purchasing and paying for the distribution of the compost and the grazing management, and then the land owner and the grazing manager would receive the benefits of increased forage production, drought resistance, and, if possible, part of the carbon market proceeds, as well.

Mr. HUFFMAN. Thank you. Any other witnesses care to comment?

Dr. TEAGUE. Yes, I would like to add to that. I am working with a group down at Patagonia. They are working with the Patagonian apparel company who insists on environmentally friendly stuff that they buy to produce their products.

We have instituted the formation of teams to train up the ranchers how to ranch more environmentally friendly, and the teams also do some monitoring to make sure that they are actually moving in the right direction. There are five levels of accreditation. The top two can sell their product at an increased price to the Patagonia company.

So, not only are the improvements in the soil helping productivity and profitability, but then you add to that the value of the product they are selling. So, basically, that is a model that will pay for itself.

Mr. HUFFMAN. Yes. So the point is, not only do we get an environmental premium and a carbon management premium, we may get an economic premium——

Dr. TEAGUE. Yes.

Mr. HUFFMAN [continuing]. From this type of management.

Dr. TEAGUE. Yes.

Mr. RICH. I would also like to add, answering a couple of questions, I certainly see the value of adding compost or other organics. We are dealing with many millions of acres. And if that can be worked out, then it certainly gives us a jumpstart.

But I would like to point out that it is possible to start with relatively degraded land, and using the appropriate livestock, we can get whatever kind of vegetation will grow, and manage it in the same way with sufficient rest and et cetera. And after jumping two or three thresholds, then we will start sequestering carbon, but we will build the health of that soil up until we get to that threshold.

Mr. BISHOP. OK, thank you. Mr. Holt?

Dr. HOLT. Thank you, Mr. Bishop. And I thank the Chair for arranging this hearing. This is the sort of hearing that we should have more often. I appreciate your doing this, and there is a lot to think about here.

I would like to start by getting this in perspective. I think it was Mr. Rich who said that we should all play golf like PGA champions. Unfortunately, neither we do, nor do all farmers or ranchers play like—do their work like champions. And so, you know, there is, among us scientists, there is the old joke about the scientist presenting his "typical observation," which means the best result he ever got. So, I think we really do have to look at what can typically be done, what the management, as it would be applied by actual humans, could result in.

Mr. Wick, you commented that if all of the manure in the state, I think, was composted, or from the dairy farms that is, was composted, it could cover 40 percent, I think?

Mr. WICK. A quarter of——

Dr. HOLT. A quarter, 25 percent——

Mr. WICK. Yes. That is all of the organics in California. So the dairy——

Dr. HOLT [continuing]. Of the land, so that you could capture carbon equivalent to what is released by the agricultural sector.

Mr. WICK. Oh——

Dr. HOLT. Did I understand that correctly?

Mr. WICK. No. I would like to restate that.

Dr. HOLT. If you would, please.

Mr. WICK. Yes, it is much more exciting than that. A one-time— I am sorry, I have to get the right note here. But, basically, 5 percent of California, treated with compost, would offset all of California's agriculture and forestry sector.

Dr. HOLT. That is what I am saying.

Mr. WICK. Five percent.

Dr. HOLT. Five percent. I see. And yet, if there is enough compostable manure to do five times that much——

Mr. WICK. Much more, yes, if that is the correct number, yes.

Dr. HOLT. OK. Well, this doesn't quite agree with the earlier testimony, the other testimony, because agricultural carbon emissions are a few percent of total carbon emissions. So, if we could do several times, even five times agricultural emissions, capture that, we are still far short of capturing the carbon emissions of our society.

Nevertheless, I think it is possible that the sequestering——

Mr. WICK. Can I take exception with that? Is that——

Dr. HOLT. Yes, please. Yes, please. Set me straight.

Mr. WICK. I believe, actually, the agricultural footprint is larger in California. I don't have the number on the top of my head, but it is much more significant than just a few percent, and that is what is important about this.

I mean we could revisit this later when we have the data in hand, but we were excited by this, because the potential of this is huge.

Dr. HOLT. Yes. Well——

Mr. WICK. And it is worthwhile.

Dr. HOLT. You know, and I think that is—we do—you are absolutely right, we do want the data in hand.

Mr. WICK. Yes, and——

Dr. HOLT. I don't think we should be running out of this hearing——

Mr. WICK. OK.

Dr. HOLT [continuing]. To say, "Fine, let's turn all public lands over to grazing, it will be wonderful." I do think there are real possibilities.

Now, I am still trying to understand, Dr. Teague, what it is about grazing, per se, that makes this work. I mean what is the magic juice here?

Dr. TEAGUE. If you recall the first slide I put up there, the way the cows distributed themselves on the landscape, they stuck to certain areas. And even though you correctly stocked for the whole landscape, they stick to a smaller area, and they overgraze those areas.

Dr. HOLT. I understand. Overgrazing is bad.

Dr. TEAGUE. That weakens those plants, OK?

Dr. HOLT. But why grazing at all?

Dr. TEAGUE. Go to slide 2. If you leave that area—in dry areas you have to recycle nutrients. If you break down the nutrient cycling, and you don't defoliate those plants, burn them or something like that, then the whole situation is static, there is nothing to feed the plants.

Dr. HOLT. So is the key here——

Dr. TEAGUE. They are dead plants.

Dr. HOLT. The key here is the manure from the grazing animal.

Dr. TEAGUE. That is part of it. But the other one is the——

Dr. HOLT. Is that right? Is that the key?

Dr. TEAGUE. That is a key. The other part is if you have a dead plant sitting up there, how much photosynthesis is it bringing in?

Dr. HOLT. Why does the grazing bring that plant back to life?

Dr. TEAGUE. Because you knock it back and you restore the nutrient cycling. If you graze——

Dr. HOLT. So it is the manure that is the key to this.

Dr. TEAGUE. No, it is also the plant roots. If you graze a plant that is healthy, a small percentage of the micro-roots die off. They immediately are gobbled up by bacteria, which, in 2 days, they—nitrogen, which jumps that plant up, and it starts growing again. If you don't have the grazer in there, you get the tall plants growing up, the leaves die, and they self-shade, and it shuts down your capture of energy, and it slows down your nutrient cycling completely. Your ecosystem fails to function.

Ms. MARTIN. Just for 1 minute on that——

Dr. HOLT. As you choose, Mr. Chairman.

Ms. MARTIN. The grazer is dependent—Mr. Holt?

Dr. HOLT. Well, my time has expired. I am asking the Chairman if he wants you to continue.

Ms. MARTIN. Can I answer?

Dr. HOLT. I am happy to hear your continuation.

Ms. MARTIN. That plant is as dependent upon that grazer to bite it, as that grazer is dependent upon that plant for food. And we could go into that in greater detail, but that plant evolved—has to have a grazer, or some event like a fire. But generally it is a grazer. It has to have that grazer to go ahead and do its job. Just like that grazer——

Dr. HOLT. And that is to reduce the self-shading. Is that——

Ms. MARTIN. That is exactly right.

Dr. HOLT [continuing]. Right, Dr. Teague?

Ms. MARTIN. And so that it will go on——

Dr. TEAGUE. And keep the nutrients going.

Ms. MARTIN. It will go on and do photosynthesis.

Dr. HOLT. And the manure and the fertilizer.

Ms. MARTIN. Yes.

Dr. HOLT. OK, thank you.

Mr. BISHOP. Now you know I have to love that cow you hate.

So, Mr. Grijalva, do you have another round of questions?

Mr. GRIJALVA. Yes, I—excuse me. Some clarification.

Dr. Teague, extreme conditions, they make climate change more severe, they prolong the droughts, they have huge impacts, not only on the land, but on wildlife habitat, wildfire. By incorporating the holistic approach and active approach to grazing that you outline, that livestock management can facilitate—in your testimony you state, "can facilitate the provision of essential ecosystem services, increase soil sequestration, reduce environmental damage caused by current agricultural practices."

This seems to suggest that livestock management will solve all—almost all of our climate change problems, even though when we have—when extreme conditions exist, even during those times. But does this mean that wildlife and endangered species that are already on the brink of extinction, who compete with livestock in that environment, how does that fit together, in terms of wildlife and species that perhaps are on the verge of?

Dr. TEAGUE. The wildlife depend on a healthy ecosystem. Global warming is supposed to—in our area, to create a warmer, a hotter, and a drier environment. If you have soil that is uncovered with weak plants, that soil gets baked in the extra heat. You don't capture as much water to get in the ground and grow things.

Mr. GRIJALVA. OK.

Dr. TEAGUE. If you manage so that you cover the ground, and you have more productive plants that then cover the ground all the time, you mitigate, you increase the ability of that ecosystem to survive the dry periods.

We just had three horrendous droughts in a row in our neck of the woods, and the guys who are using the methods of grazing we are talking about, well, they have had some of the best years yet, because—I was at a workshop, and one of the guys was asked the question, and he said, "I have managed for 25 years to make sure I've got deep roots, I got the right plants, I got the soil covered." He is still making money; his neighbors are out of business.

Mr. GRIJALVA. Does——

Dr. TEAGUE. So there is——

Mr. GRIJALVA. On that point, does grazing at a larger scale than we are talking about presently, does that impact water resources?

Dr. TEAGUE. Absolutely, because if carbon dioxide is getting in the ground, that facilitates water getting in the ground. So the percentage of moisture that comes in as precipitation, a greater percentage of it stays in the soil if you have high carbon. If you have bare ground, it all runs off.

Mr. GRIJALVA. One last point, one last question, if I may, Doctor. Do you believe that we should take steps to mitigate the impacts of manmade greenhouse gas emissions, for instance? And—OK. Do you believe we need to take steps to that? And is grazing the only method to mitigate those greenhouse gas emissions that Congress, at this juncture in history, should consider?

Dr. TEAGUE. We have a lot of things that we have to do. I am dealing with people who are managing the land. What I am working on is what will keep them in business, what will keep our ecosystems functioning and our watersheds functioning. And looking after carbon dioxide covers that base, as well as dealing with some of the climate issues, as well. So it is just part of the whole picture we have to address.

Mr. GRIJALVA. But there are other models.

Dr. TEAGUE. Beg your pardon?

Mr. GRIJALVA. There are other models, as well.

Dr. TEAGUE. Well, I have told you about the causal mechanisms, what causes degradation, and what brings it back from degradation. If you manage in a manner that affects those things, you will minimize the damage.

Mr. GRIJALVA. So limiting emissions would be made moot because of the approach that you are talking about, correct?

Dr. TEAGUE. Well, if we were only emitting a few things, that would be true. But we are emitting so much now, the way we do business as a larger society, that is not the case. We have to reduce emissions as well.

Mr. GRIJALVA. Thank you. I yield back.

Mr. RICH. May I speak to the endangered species issue that Mr. Grijalva brought up?

Mr. BISHOP. Actually, no. But let me ask the question.

Speaking of endangered species——

[Laughter.]

Mr. BISHOP. First, I want to let—Supervisor Martin, I cut you off. If you have more to the testimony you were giving about your hay, first. But then I would like to come back to this concept of endangered species. Because apparently, with sage grouse, for example, in Utah there is one ranch that seems to have an overabundance of that bird. They are obviously doing something that attracts it, as the neighboring Federal land is not attracting the bird. So I want to know how this impacts endangered species.

But I cut you off, Supervisor.

Ms. MARTIN. Well, and it also answers—I think it addresses Mr. Grijalva's conversation, too. USDA figures show that if you will take a block of soil, 1 foot by 3 foot by 6 inches, you have something that weighs about 100 pounds. If it only has 5 percent organics in it, it will hold twice its weight in water, or 200 pounds. That is the equivalent of a 6-inch rainfall in an hour.

It absolutely affects the water conversation. You will see ranch after ranch that is practicing this, that will say to you, "We are having to haul water now, because the rain that falls now soaks in." We don't have storm drains any more, that when it storms they drain—instead the creeks, we now have creeks. It is a fundamental effect. And it is to the organics incorporated into the soil, one way or the other, through proper grazing, through outside inputs. It is the getting it started. And that was probably the rest of that conversation, sir.

Mr. BISHOP. Appreciate it. Mr. Rich?

Mr. RICH. Yes. On that one ranch, just as an example, they have 300 bird species. They have been designated by the Audubon Society as a worldwide important bird area. And they have 20 percent of the sage grouse in the State of Utah on about 5 percent of the habitat. The Bonneville cutthroat trout is out of danger. The pygmy rabbit is out of danger on this land. The white tail prairie dog is widely abundant on this ranch, entirely out of danger. There are—they are famous for their other wildlife: elk, deer, moose, et cetera, et cetera.

They have tremendous amounts of raptors, you know, birds of prey. You are never out of sight of an eagle or a large hawk. You will see more coyotes in a day than you will generally see—than a lot of people see in a lifetime. It is an entirely different world, where endangered—I mean it is really pointless to try to introduce endangered species or try to recover them without recovering soil carbon.

If you do that, then it works itself out. Like, if you want to have wolves, you have to have a very productive ecosystem, or else you have what is happening in Yellowstone now, which is a 90 percent decrease in the elk population. They just can't keep up with the predation. And it is because of documented degraded resources in the northern part of Yellowstone.

Ms. MARTIN. Steve, I would like to piggy-back on that. Mr. Chairman, I know that if these Members are truly interested in seeing this in action, that the Deseret Ranch welcomes field trips. And I would suggest if anybody would like to go look——

Mr. GRIJALVA. It is nice.

Ms. MARTIN [continuing]. That we gather up and we go. Go look for yourself. Go talk to those folks yourself. It is an exciting—and part of what is so exciting to me, again, on that 202,000 acres, they are making $3.5 million every year, year in and year out, $17 an acre. Now, that is a huge economic benefit——

Mr. RICH. In the cow business.

Ms. MARTIN. That is in the cow—yes. Come go with us.

Mr. RICH. I want to emphasize they are making that money in the doggone cow business, you know, which is famous for not making any money. So that is a 50 percent net profit. Just want to make that clear.

Mr. BISHOP. OK. And you just have to remember Deseret Ranch is in my district. So be careful who you are inviting to Utah, would you?

Ms. MARTIN. All but you are welcome, yes.

Mr. BISHOP. Got to look carefully here. I am going to—we have votes planned at about 3:30. So I am going to go as far as we can with the questions that we have. I have other questions, but let me stop my time here and go on—Mr. Huffman, do you have other issues?

Mr. HUFFMAN. I just wanted to give the witnesses an additional chance to comment on the side bar that Dr. Holt and I were having here, which is he is struggling with grazing versus no grazing. We were having a little side bar about how, in the state of nature, there were these huge herds of grazing animals, the bison, the antelope, that no longer exist in those type of numbers, and that, to some extent, the type of grazing that you are talking about here may be replacing a natural function, and that may be—I was speculating that may be part of why this works with the natural system. But——

Dr. HOLT. If the gentleman would yield——

Mr. HUFFMAN. Yes.

Dr. HOLT. Just for clarification so the witnesses can work with this, my question has to do with to what extent grazing is a compatible use of the land in which soil—sequestration of carbon is taking place, and to what extent it is a necessary part.

Mr. HUFFMAN. Yes, good.

Ms. MARTIN. I will say that it is an incredibly necessary part. And I think the struggle you are having is one that I call the "man in management." It is not the cow, it is not the buffalo, it is the human that is directing what they do and how long they are there. And it is understanding that overgrazing is a function of time, not animal numbers, and getting your head around that—and we can talk about more of that, if you want to—but overgrazing is absolutely caused by—and on Federal land right now, it is caused by the very rules and regulations we are talking about. You are forced into overgrazing, following Federal rules and regulations.

So, the first thing that has to happen is a lessening of those, which is why I had asked for demonstration areas, so that we can all learn together what that means, and we learn it in a very structured and researched way on different soil types, so you don't have to eat the elephant all at one time.

And I will have people say to me, "Well, there's all demonstration areas everywhere." There are, but it is a different thing when you are involved, personally, in looking at that.

Mr. HUFFMAN. Can you elaborate on that? What is it about existing Federal regulations that you think mandate overgrazing?

Ms. MARTIN. Overgrazing can occur in as little as 5 days, depending upon the rate of growth and the animals that you have there. And Federal regulations will make you stay in that place 30 days up to 90 days. There is no way you cannot overgraze. You become what I call instruments of your own demise. You are forced into following those regs, or you are kicked off. And if you follow them, you are putting yourself out of business, and you are impoverishing your area. If you need to move in 5 days, you need to move in 5 days, and you need to let the pasture determine the action, not the calendar.

Dr. TEAGUE. The definition of overgrazing is grazing a plant after it has been grazed already before it is recovered. Because as soon as you do that, you lose root volume, and everything goes negative after that point. And if they have undisclosed activity, they will work from a point—they visit numerous points, and they will find the previous patches they grazed 2 or 3 days before, and they will go back and hit the same ones all the time. That is why you need to graze for a short period, move on somewhere else.

Ms. MARTIN. And there are ones that they are overgrazing because they are trying to recover—they are so much higher in nutrients. That is why they go back to them.

Dr. TEAGUE. Yes.

Ms. MARTIN. They are not stupid about that. You have to have them moved to be able to go to the next pasture and the next pasture.

Mr. RICH. I would like to comment on what—on this thing. The—suddenly I can't remember your name.

Dr. TEAGUE. Richard.

Mr. RICH. Richard. The thing Richard was saying about getting the livestock spread out is very important. There is a concept called the grazing lawn that Dr. McNaughton and Augustine and others talk about. These are structures where there is enough dung and urine and et cetera that is deposited to increase soil fertility.

Done optimally, the way Dr. Teague and the rest of us are suggesting, then the entire ranch becomes one of these structures, which is why we get so many more birds and so many more everything else, is because the forage quality goes up so much, as does the volume. And John Wick will testify to that, that forage quality increases dramatically, and forage volume increases dramatically.

Mr. WICK. It is true.

Mr. BISHOP. Mr. Grijalva, you have more?

Mr. GRIJALVA. Just let me follow up on—did you point to me or Mr. Holt?

Dr. HOLT. No——

Mr. GRIJALVA. Oh.

Dr. HOLT. I don't care about the order.

Mr. BISHOP. Go ahead.

Mr. GRIJALVA. You go.

Dr. HOLT. Well, all right, thank you. Thank you. So I don't doubt that overgrazing is incompatible with capturing and keeping the carbon in the soil. But I guess I would like to be pointed to solid research that grazing up to that overgrazing is—improves the sequestration or is necessary for the sequestration of the carbon.

Dr. TEAGUE. There has been some exceptionally good work. Dr. McNaughton is probably the leader.

Dr. HOLT. Naughton. OK.

Dr. TEAGUE. Studying natural grazing systems, which, in their natural state, are dominated by large grazers, buffalo, et cetera, in large herds, and they move around all the time, so they have a transitory effect. But that effect maintains the grasses where they are green and capture—keeps the soil nutrients cycling.

If you remove all those animals from that area, you get lots of growth that looks really good. But the next year you have a lot of dead grass standing there. You are getting very little photosynthesis. You are getting no turnover in the nutrients. Things close down.

Now, your insects, which are important for the birds, which are important for the higher stages, they need that green stuff with a high nutrient turnover and green material that provides the energy to keep the whole ecosystem going. The soil microbes, the plants, the insects, all the animals of the different ecological stages depend on each other. They evolve together. If you now suddenly take those out of the picture, the whole shebang comes down like a pack of cards around your ears. Grazers are essential for ecosystem health in grazing ecosystems.

Ms. MARTIN. And to answer your overgrazing, you are dead right about overgrazing releases carbon. That is one of the reasons we have released the carbon is because of the poor grazing practices. You are not wrong there. It is just simply learning how to reverse that, OK?

Dr. HOLT. But for the—Dr. Teague, in the example or the description that you give, it may well be that if the roots are as deep as they are going to go, if that is accomplished in some way, and the grasses, the plants, whatever, grow large and don't continue to grow, they are still holding that carbon.

Dr. TEAGUE. That is correct.

Dr. HOLT. And so it may be that you don't need next year's growth. In other words, you don't have to cut and release all that carbon, so that next year you can store more carbon.

Dr. TEAGUE. OK, here is a scenario——

Dr. HOLT. And so—and, by the way, and you cut out the methane in the process, too, if you leave the plants to their own.

Dr. TEAGUE. OK. So you have a little grass standing out there, and it is dead, and a lightening storm comes along, and it sets the world alight, and you burn the whole landscape. You have bare ground. You know what is happening there? You are losing soil, you are losing carbon dioxide. The whole shebang comes down around your ears. And once you have lost that, you can't get back to where you were before. You have to manage like the natural ecosystems without exceeding the bounds in terms of overgrazing or undergrazing. There is a neat area in the middle where everything works. You step outside of that either way, and it ceases to work.

Dr. HOLT. Good. Well, I thank you. I thank the Chair for the time.

Mr. BISHOP. Thank you. Grijalva?

Mr. GRIJALVA. Very quickly, Supervisor, you were talking about the management, and that maybe—or, well, in your mind, yes, existing policies, grazing policies, regulations actually make the situation worse, rather than better. This holistic approach, using the public lands as a sequestration area in terms of grazing, looking ahead, how do you pay for something like this?

And I say that because who is going to be responsible for the management on the public lands, number one. Number two, we are 115 million short as of 2004, the last study on collected fees versus the cost of managing that. And who—where would the prerogative of management be, as you see it? Would it continue to be with the Federal Government, or do you see something else?

Ms. MARTIN. Let me take you back to the Deseret Ranch. It is Forest Service, BLM, and some private. OK? Now, I just keep using them because they are such a stellar place. But they are not the only one. Most is on private land that you are—looking at these kinds of examples, because you are not allowed to do this on public land. You are not allowed to move critters as fast as you need to.

Mr. GRIJALVA. Are there public lands where—what we have been talking about today, in terms of this concept, are there public lands in which ranchers want to do that?

Ms. MARTIN. Oh, yes. We would do it in a heartbeat——

Mr. GRIJALVA. With grazing permits?

Ms. MARTIN. Oh, yes. And you wouldn't have to pay them, you just have to get out of their way.

Mr. GRIJALVA. No, they might want to try paying us, but that is a different story.

Ms. MARTIN. They could pay you. Tell me that I wouldn't rather have——

Mr. GRIJALVA. More than the state—the state charges more.

Ms. MARTIN. Tell me I wouldn't rather——

Mr. GRIJALVA. Private land—OK, I am just——

Ms. MARTIN [continuing]. Have $17 to the acre and the receipts of that, rather than——

Mr. GRIJALVA. Well, in tough economic times I am for cost—pay-as-you-go and cost recovery. And I think that concept would be important in this case, too.

But, Dr. Teague, there is—you know, my neck of the woods and other parts of the West, you mentioned—somebody mentioned the 3 or 4 years—I think we are going on 5—droughts in—and those arid lands have become more arid. And the question I have, are there systems in which what we have been talking about today is not compatible?

Dr. TEAGUE. We still have to do a lot more research. But going on experience from working with the ranchers from numerous places, this basic model works in a lot of areas.

I mentioned earlier when you were out, Patagonia, I am working down there, and many of those areas are 10 to 15 inches of rainfall. And they were in a seriously degraded situation, so that even—so that the farmers who were trying to make a living there, many of them have had to leave the land.

The Patagonia Company came along and formed a——

Mr. GRIJALVA. So is there a system—are there presently systems in which the approach we are talking about today is compatible or not?

Dr. TEAGUE. Yes, from 10 inches of rainfall up to 80 inches of rainfall.

Mr. GRIJALVA. It is compatible?

Dr. TEAGUE. Yes.

Ms. MARTIN. Well, and we——

Mr. GRIJALVA. And so, in extreme arid areas it is not?

Dr. TEAGUE. Well, if it is desert. If it is grassland that can hold a grazer, even if it is degraded you can bring it back under the right——

Mr. GRIJALVA. Or certain animals in the North American Great Basin?

Ms. MARTIN. Mm-hmm.

Dr. TEAGUE. Yes.

Mr. GRIJALVA. OK. All right, thank you. Yield back.

Mr. BISHOP. Let me try and—we all keep plowing ground that I find interesting.

[Laughter.]

Ms. MARTIN. He is losing carbon if he does that.

Mr. BISHOP. Because I like hamburger more than he does.

So, Mr. Teague, you have had experience in international issues. Are there examples internationally of this concept? And are any of those applicable to what we are talking about that could be here in the United States?

Dr. TEAGUE. Yes. I visited Australia, South Africa, and many of their dry areas are the first areas to implement these changes, because, under bad management, they degrade pretty quickly. But many of the really best examples have taken place. And after 10 years of really good management, they have recovered to the point of being damaged, completely dominated by grassland, whereas previously that would be just bare ground.

It can be done. You have to have the right people doing it.

Mr. BISHOP. So in Australia you are talking about—are these government-managed areas?

Dr. TEAGUE. No.

Mr. BISHOP. Private-managed areas.

Dr. TEAGUE. The government in Australia is absolutely immune to thinking of any other way of managing, other than their way. But the people who have achieved really good results have followed the system that we are talking about now.

Mr. BISHOP. Is there anything—Mr. Wick, I am assuming that the grasses that you are growing on your farm in California are perhaps different than what we are talking about in most BLM land in the Intermountain West. I am assuming some are annual, some are perennial. Does that have a difference, the kinds of vegetation we are talking about, does that play any kind of difference in the role of the results we might get?

Mr. WICK. That is an interesting question. I don't know about that area. I know about my ranch, and my management has been to promote the perennial grasses with the deeper roots. And so I am seeing success with that. That suggests that there is more carbon going into the soil through roots, and ultimately ending up in a more stable form. So that is an anecdotal observation of mine. All our data is based on the compost application.

Mr. BISHOP. OK.

Mr. WICK. As a rancher, what I have seen is green grass all summer in the perennials, and that is very exciting. So I can use my grazing management to achieve a stronger population of perennials without planting a seed. They seem to buffer or withstand a drought better than the annuals, prolonging my growing season. And then, on the composted plots, what we have seen is an incredible explosion of the native perennials within the boundaries of the research plots. So the improved soil health, the native plants respond really well to that.

There is some suggestion that California, at least, was green year-round. There is not much evidence—you know, that was a while ago, that was 150 years ago. But the plants seem to be in the soil, the seeds are there. And so, if we manage for them, they express themselves.

Mr. BISHOP. The kinds of vegetation we are using has an impact and has a difference, then.

And, Ms. Martin, I have 2 minutes. Let me try an entirely different area dealing with Forest Service. You have worked with the Forest Service having asked you to put small water tanks all over the place to stop small forest fires from becoming big. Is that replicated anywhere else?

And have you seen anything else with healthy forest initiatives where this concept, what we are talking about, could be applied to the forest, as well?

Ms. MARTIN. On the first one, a couple of counties are beginning—we have been doing this since 2006, and we do have some counties through the West that are beginning to try and duplicate this. Whether they are actually setting up the tanks, or they are making deals with people that have swimming pools that they won't take the roof off with their rotor wash when they dip out of it, they are beginning to do that in some of the areas.

To start with, we were saying—they were telling us, no, this is a Forest Service problem, and we were saying, no, it is all of our problem. We need to what I call hold the fort, if we can, until we get industry in. And that, to me, is the second piece of this, is to bring industry in, and let them profit by cleaning out these forests, in particular, which goes into your conversation about forest health.

Again, my great-grandmother saw 30 trees to the acre. I am looking at up to 3,000. When you have that many straws in the ground, every little dry spell is a drought. It also is a fire hazard that you can't believe. We have to get in there and get that cleaned out.

We are doing some things in Arizona. It is called, the Four Forest Restoration Initiative is one of them, to where we bring everybody together and get that cleaned out. Once it is cleaned out, then the very things we are talking about, you can go back onto that forest floor and do this very thing, beginning to sequester carbon, both through the trees—trees have a different root system, they are more lateral, and they sequester carbon in their wood. And so your wood products harvest that carbon and keep it stored.

But if you will also have a component of grass on that ground, you can begin to put it in much deeper. Grass plants will take it down 15 feet, where a tree won't take it down a foot, in some cases. But I don't know if that helped answer, but——

Mr. BISHOP. That did. And maybe, if we have time, we will talk about the cooperation you are having with the Forest Service as well, there. No more. Mr. Holt?

Dr. HOLT. Just a comment about the Forest Service. I was just looking it up right here. In the western United States, forests sequester about twice as much carbon as grasslands and about eight times as much as agricultural lands. Just an interesting figure. So you are right to talk about working with the Forest Service.

Mr. WICK. Could I comment to that, or——

Dr. HOLT. Yes, if you have a comment on that.

Mr. WICK. Yes, I would. I would like to then consider what the potential of grasslands are, in terms of additional carbon sequestration.

Dr. HOLT. Of course that is the point of today's discussion.

Mr. WICK. Right.

Dr. HOLT. And I appreciate that.

Mr. WICK. Yes.

Dr. HOLT. And it may be huge.

Mr. WICK. And I believe it is, and I would like to find out——

Dr. HOLT. Thank you.

Mr. WICK [continuing]. A way to get that information to you when we get it.

Dr. HOLT. No further questions from me. Thank you, Mr. Chairman.

Mr. BISHOP. Supervisor, can I just follow up? Is the Forest Service cooperating with you on these efforts in forest restoration?

Ms. MARTIN. Yes and no. The folks are cooperating. The culture and the process works against that. I believe that in this one case that we are talking about, 4–FRI, that a compromised contracting process is going to stall us in our tracks, if we are not careful. It almost has.

And what I mean by that, they—a contract was let in May of 2012 to get started on cleaning 300,000 acres on these four forests in Arizona. We should have cleaned 15,000 acres in 2012, we should have cleaned 30,000 acres in 2013, and we should be working on our second set of 30,000 acres, so at the end of the year—we had 45,000 acres by now, and we should be doing 30,000 more. We have actually cleared 1,200 acres in that same timeframe.

They picked a contractor that didn't have the financing, that didn't have the expertise. That contractor, a year-and-a-half later, flipped it to somebody else who, a year later, hasn't done any more. And while they fiddle, we are getting ready to burn. And it just frustrates me no end. I don't know where the log jam is. One of the things that I would like to have you all help, if you could, is help me find where that log jam is, and get with this.

Mr. BISHOP. Thank you. I have some ideas where it is, too, but we will save that for another time.

Mr. Rich, if I can—hopefully, as we are coming close to the votes here—you wrote about an incident in your written testimony that was raised in, you said, a NEPA document about a cow eating a threatened fish. Sounds strange, but could you just explain that to me?

Mr. RICH. Oh, it is much worse than that. It was Federal scientists repeatedly claimed that not a cow, but cows in general, eat endangered fish. They also claim that they eat endangered fish eggs, and that they step on the redds of—redds are fish nests, essentially—that they step on and destroy the redds of species of fish that do not make redds.

There is kind of a game that a lot of Federal employees play. They just see how much you can injure the ranchers. And science, or truth, have nothing to do with it whatsoever.

Mr. BISHOP. Is the name Gene Govens?

Mr. RICH. Govens? Gene Goven? Yes. He is a rancher in Turtle Lake, North Dakota. And he is one of the ones we look to. He—for instance, the Fish and Wildlife Service has turned a small wildlife reserve over to Gene, because all of the birds on his land. And so he is now managing the reserve, as well. But he makes 20 percent net return on investment, is my understanding.

And he, furthermore—anyway, he has gone from dry land species to tall grass prairie species on some of the driest areas. And that is one of the dynamics that we have to understand. People talk about sequestration ending when we fill these soils up with carbon. All that really will happen is, as we get more carbon, we will grow taller and taller organisms, and have deeper and deeper root zones.

We will not saturate before we run out of CO_2. Might have to have the Chinese burn more coal.

Mr. BISHOP. I thank you, and I hope those species on his ranch are not endangered, because otherwise Fish and Wildlife won't count them when they are over there.

Are there any other questions for these witnesses?

Mr. HUFFMAN. Just wanted to thank you, Mr. Chair. We were doing almost perfectly until we wandered in the very end into some politically treacherous areas. But I think this was a very refreshing hearing, and I think this was the best of the oversight function, and has certainly ignited some ideas, I am sure, with many of us on how we might work together to explore the possibilities. And I appreciate the witnesses and appreciate your leadership, Mr. Chair, in pulling this together.

Mr. BISHOP. Thank you. I want to thank you all for making the trek out here. I appreciate it very much, for taking the time with us. There may be some additional questions that people will have for you. We would ask you to respond to those in writing in a relatively short period of time, if you would do that.

I appreciate what you are saying. It is requiring, I think, that we have seen the opportunity of thinking outside of the box. Sometimes thinking about things that are counterintuitive as a solution. And what we now have to do, from this testimony, is figure out what the next step is.

Because I think you have identified something that could be an extremely effective way not only to improving our livestock, and improving our wildlife, and improving our range conditions and our lands, but also being a way of improving the climate, and carbon sequestration, and helping all sorts of people getting something—this could actually be a very win-win situation, if we were actually to implement these things on Federal lands in a large way. So, I appreciate you being here. This is the first step, obviously, of what we are doing.

Do you have a benediction you want to give there, Mr. Wick?

Mr. WICK. Well, I would just like the opportunity to come back before this group to present further research results, as we move forward.

Mr. BISHOP. I appreciate that. And you also have the written way in which you can contact us, as well.

Mr. WICK. Thank you.

Mr. BISHOP. So I thank you for that. If there is nothing else, without objection, we are adjourned.

[Whereupon, at 3:32 p.m., the subcommittee was adjourned.]

[ADDITIONAL MATERIALS SUBMITTED FOR THE RECORD]

PREPARED STATEMENT OF THOMAS L. FLEISCHNER, PH.D., DIRECTOR, NATURAL HISTORY INSTITUTE & PROFESSOR OF ENVIRONMENTAL STUDIES, PRESCOTT COLLEGE, PRESCOTT, ARIZONA (CHAIR, PUBLIC LANDS GRAZING COMMITTEE, SOCIETY FOR CONSERVATION BIOLOGY, 1993–94)

Issues of Concern with W.R. Teague's testimony at the Subcommittee on Public Lands and Environmental Regulation Oversight Hearing on "Increasing Carbon Soil Sequestration on Public Lands"

Having read Dr. Teague's testimony, I would raise several issues of concern. Most of these issues involve what he does not include in his analysis, rather than what he does. Listed below are several overlapping issues

1. There is an unstated but clear assumption in Teague's testimony that *there shall be grazing*. Thus, his comparisons are between management that is somewhat engaged and aware and management that is not (traditional range management often involves turning livestock out, untended and unchecked, for months at a time). Given this comparison, it is unsurprising that he finds his preferred multi-paddock approach to be superior. Simply put, there is more carbon sequestration in landscapes with some vegetation than in those with little or none (as has been the result in many parts of the arid West). What he fails to do, consistently, is compare any grazing approach with a management strategy that leaves livestock off the land.
2. Under any grazing management system, less carbon is going to be sequestered with livestock than without livestock. Indeed, *the whole point of livestock grazing is to export carbon* (in the form of meat)!
3. He states that "The key to sustaining and regenerating ecosystem function in rangelands is actively managing for reduction of bare ground . . ." I agree. Why, then, does he refuse to consider any non-grazing treatments, which are more likely to maintain plant cover?
4. He completely disregards the impacts of livestock grazing on western riparian habitats. These streamside habitats are, by far, the most productive and biologically diverse habitats in the arid West. It is widely documented that when given a choice cattle will select riparian habitats over surrounding arid uplands (no surprise, given the presence of water, shade, and forage). It is also well documented that livestock cause serious degradation of both terrestrial and aquatic riparian habitats. Even those these habitats comprise a tiny percentage of the West, they hold enormous importance for biological productivity and biological diversity. Any analysis of Western ecosystem functioning that ignores riparian zones provides a very incomplete view of ecological impacts of grazing.
5. Contrary to many anecdotal stories, there is no scientifically substantiated evidence that multi-paddock (=Holistic Management, =short duration grazing) grazing achieves the results claimed by Allan Savory.
6. Contrary to popular misconception, there were no large native herbivores (ie, bison) in most of the arid West (west of the Rockies). Bison were abundant on the Great Plains, but mostly absent from the regions west of the Rockies. Thus, there is no validity to ideas that livestock somehow "replace" native grazers.
7. *Teague's analysis fails to address another of the most important aspects of carbon cycling in arid landscapes—biological soil crusts.* Soil crusts play essential roles in retaining water, establishing seedbanks for vascular plants, and resisting soil erosion. Soil crusts are almost always absent in sites currently grazed by livestock. Because Teague's analysis failed to look at ungrazed ecosystems, he was unable to see the most effective approach to carbon sequestration, which is allowing soil crusts to restore themselves in the absence of livestock (as has been documented in Chaco Canyon, NM, by Floyd et al. 2003), and for ecosystems with native species composition, function, and structure to flourish once again.
8. Note the use of terms like "conservation rancher" and "regenerative grazing"—further indications of the lack of considering options outside the livestock realm.

CARBON CYCLE INSTITUTE/MARIN CARBON PROJECT,
JULY 4, 2014.

Hon. ROB BISHOP, *Chairman*,
Hon. RAÚL M. GRIJALVA, *Ranking Member*,
Hon. RUSH HOLT, *Committee Member*,
Hon. JARED HUFFMAN, *Committee Member*,
House Subcommittee on Public Lands and Environmental Regulation,
Washington, DC 20515.

Re: Comment on Oversight Hearing on "Increasing Carbon Soil Sequestration on Public Lands," Wednesday, June 25, 2014

Thank you Chairman Bishop, Ranking Member Grijalva, and members of this subcommittee for convening this important discussion at this critical time. As a rangeland ecologist and co-founder, with Mr. John Wick, of the Marin Carbon Project, and having watched the hearing live via a web connection, I hope my comments below will help clarify some of the issues discussed.

1. Ranking Member Grijalva's suggestion that carbon sequestration "sidelines" the grazing fee discussion.

Ranking Member Grijalva suggested that talking about carbon sequestration on public lands "sidelines" the issue of excessively low grazing fees on public rangelands. Originally conceived as a public good due to the production of food and fiber to meet the needs of a growing nation, public lands grazing has in recent years increasingly been viewed as a public subsidy of private enterprise, often with further public cost in the degradation of public lands through poor livestock management. Discussion of how public land lessees might actively participate in a climate change solution raises the possibility of once again viewing grazing on public lands as a public service.

While much of the criticism of grazing and low grazing fees is well founded, it must not blind us to the possibilities of using appropriate livestock management practices to achieve the types of climate and ecosystem-beneficial results outlined by the panel of expert witnesses during this hearing. Such beneficial practices may indeed lend themselves to "subsidy" by a rational society seeking viable solutions to address the rapidly worsening global ecological crisis driven by excessive quantities of CO2 in the atmosphere. The costs of implementing grazing practices that lead to enhanced ecosystem function, including soil carbon sequestration, should not be borne entirely by the public lands lessee, and may in fact warrant a fee for service arrangement with the Federal Government under specific circumstances. A continuum of fee schedules is imaginable, for example, under a stewardship contracting arrangement, whereby graziers are billed, or compensated, on a sliding scale based on ecosystem management services provided relative to both public and private benefits received.

Under no circumstances should public land grazing be allowed to lead to degradation of the resource, but a range of flexible fee structures would encourage best practices while supporting the technical and administrative services needed to address historical damage and oversee existing grazing leases. It is entirely appropriate, in my view, to consider payment *to* public land graziers if, but only if, the net ecosystem benefits, including carbon sequestration, can be quantified and verified as justifying such public expense.

2. Restorative conservation grazing management can reduce atmospheric CO2 to pre-industrial levels.

Both Mr. Steven Rich and Dr. Richard Teague commented that photosynthetic capture of atmospheric carbon dioxide and its beneficial sequestration as vegetation and soil carbon could theoretically reduce atmospheric levels of CO2 to pre-industrial levels. We know that until the industrial revolution atmospheric CO2 concentration oscillated between 190 and 290 ppm for at least 800,000 years. Given that the current concentration is over 400 ppm, we would need to reduce current atmospheric CO2 levels by at least 110 ppm to reach pre-industrial levels. This level of CO2 reduction may not be necessary to stop and reverse global warming, however. There is general agreement that a concentration of 350 ppm is probably an acceptably safe level of atmospheric CO2, which would require removal of approximately 50 ppm. This is clearly a more achievable target in the nearer term, and perhaps more plausible to those new to the concept of biological terrestrial carbon sequestration. A full return to pre-industrial levels is theoretically possible, but 350 ppm is both more readily achievable and probably sufficient.

3. Congressman Holt: why is grazing preferable to no grazing at all?

Congressman Holt raised the question of whether no grazing at all would not be a better option than the restorative conservation grazing management addressed by the witnesses. Both Supervisor Miller and Dr. Teague addressed the coevolution of—and mutualisms between—grazing animals and grazed vegetation. To grasp the significance of this relationship, it is critical to understand that ecosystem carbon is embodied solar energy, and as such, is the energy currency of virtually all biological systems. As noted by Dr. Teague, it is carbon, that is, solar energy embodied via plant photosynthesis, which drives all ecosystem processes, including biodiversity, productivity and resilience. Grazing by native grazers is recognized by systems ecologists as an ecosystem energy optimization strategy, and managed livestock grazing, when scaled appropriately in both space and time, leads to similar ecosystem benefits. Energy optimization, in the context of grazed ecosystem dynamics, refers to the capacity of the ecosystem to optimize the capture of solar energy through photosynthesis, and retain that energy within the system, including its long-term storage in recalcitrant soil carbon pools.

4. Congressman Holt suggested that once a plant has formed its root system and grown its above ground structure, there is no need for grazing because, he suggested, the plant has thus captured as much carbon as it can.

This perspective misses the inexorable annual cycle of growth and decay and the opportunity each new growing season—indeed, each new day—presents to both capture additional atmospheric carbon and to direct some of that carbon to the soil carbon pool by a variety of mechanisms. These mechanisms include the decay of detritus at the soil surface, the discharge by plants of sugars and other carbohydrates to the rhizosphere (the highly biologically active soil surrounding the plant root), the direct symbiotic transfer of plant carbohydrates to root-associated fungi, and the sloughing of plant roots. Each day brings a new opportunity, as environmental conditions permit, for carbon capture and a new opportunity for transfer of carbon from the air to the soil via plant metabolic processes. To the extent that grazing is managed to facilitate these processes, it is an essential component of optimizing energy flow and carbon capture in the ecosystem. While grazing is not commonly managed for this explicit objective, it can be, which is the point being made by the expert panel here.

5. Ranking Member Grijalva asked: Can holistic approaches to grazing facilitate provision of essential ecosystem services, even in extreme conditions? What are the impacts on wildlife and endangered species?

Holistic approaches to land management require the identification, *apriori*, of management objectives and both proactive and adaptive management over time to meet those objectives, or others if objectives change. Management for wildlife and endangered species can, and must therefore, be included among the management goals of rangeland ecosystems. Dr. Richard Teague discussed the mechanisms driving soil carbon sequestration on grazed lands, particularly the reduction of bare ground, moderate rather than excessive levels of defoliation, and the importance of adequate recovery periods for grazed vegetation. Dr. Teague noted that wildlife are dependent on healthy ecosystems and that by increasing soil carbon sequestration, restorative conservation grazing management contributes to ecosystem health. As noted by Dr. Teague, it is carbon, as solar energy embodied through plant photosynthesis, which drives all ecosystem processes, including biodiversity, productivity and resilience. As climate change worsens and formerly extreme conditions become more common, the importance of ecosystem resilience to protect biodiversity and maintain productivity will only increase.

6. Ranking Member Grijalva: Does grazing impact water resources?

As explained by Dr. Teague and Supervisor Miller, soil carbon increases can absolutely lead to improved watershed conditions, improved soil water holding capacity and improved recharge of ground water. This is because soil organic carbon plays a significant role in the capture and retention of water, and its slow release over time. Loss of vegetation cover leads to soil erosion and associated losses of soil carbon and soil water holding capacity; restorative grazing, by definition, leads to the restoration and enhancement of these ecosystem services. The Marin Carbon Project has measured significant ongoing increases in soil moisture in response to both surface applications of compost to rangelands and, most significantly, to increased soil carbon resulting from enhanced photosynthetic carbon capture in response to improved soil quality due to those compost applications. The implications for the West are significant: we estimate that we have more potential water storage capacity in

California's soils under an improved soil carbon scenario than all the reservoirs in our state.

7. Ranking Member Grijalva: Does grazing obviate the need for emission reductions?

Ranking Member Grijalva queried Mr. Wick on the relationship between Allan Savory's Ted talk (in which Mr. Savory claims holistic grazing alone can restore atmospheric levels of CO2 to pre-industrial levels), and the Marin Carbon Project published, peer-reviewed experimental results showing increased atmospheric carbon capture on rangelands following compost applications. Congressman Grijalva was particularly interested in whether a restorative grazing management approach alone can solve the climate crisis, obviating the need for lowering greenhouse gas emissions. As noted by Dr. Teague, we must reduce emissions, regardless of the capacity for soil carbon sequestration through enlightened management of public lands. *Reducing emissions alone, however, is not enough to reverse the climate crisis* due to the legacy load of greenhouse gases already in the atmosphere. *We must also remove significant quantities of CO2 from the atmosphere.* Biological terrestrial sequestration is far and away the safest, most reliable and least expensive approach to doing so, and is accompanied by a host of environmental co-benefits, as outlined in supporting materials provided by the panel members.

8. Chairman Bishop asked Dr. Teague to explain the disagreement among researchers on the potential of carbon sequestration through grazing.

Dr. Teague suggested this discrepancy is due to a failure of research design. Dr. Teague noted that he studies what the best ranchers are achieving; that while there is certainly degradation to be found everywhere, the key is to improve such conditions. Mr. Rich suggested the discrepancies observed are a function of different levels of management skill among ranchers, analogous to differences between professional and amateur golfers.

I would also note that ecosystem carbon dynamics, particularly the role of soil carbon as embodied solar energy with the potential to drive system change, is a new area of focus for rangeland science, and it is this lack of understanding of the central role of carbon in system dynamics that has led to the confusion and controversy we see surrounding the debate on this topic.

9. Chairman Bishop asked if it is necessary to apply compost on public lands to achieve increased soil carbon sequestration.

The Marin Carbon Project used compost applications as a way to test the hypotheses that (1) increasing soil carbon on grazed rangelands is possible and, (2) would result in further ecosystem benefits, including increased photosynthetic capture of CO2. Our results support these hypotheses, suggesting that achieving soil carbon increases by properly managed grazing alone is indeed possible. As noted by Mr. Rich, compost can "jump start" the process, but may not be needed where other appropriate strategies are employed. Supervisor Miller noted that she had achieved similar results by adding hay and animal impact on highly degraded mine spoil sites, essentially producing compost on site. She also reported similar results in a sagebrush-dominated system using only *in situ* organic material and livestock. The Marin Carbon Project has solid science on the carbon-beneficial effects of compost application to Mediterranean grasslands of California. These results suggest that other approaches to enhanced carbon sequestration on public lands can also be effective.

10. Congressman Holt suggested that compost applications to 5 percent of California would fall far short of capturing the state's carbon emissions.

Compost applications to 5 percent of California would offset all the emissions from the California agricultural and forestry sectors in the first year of application. It is important to understand, however, that the offset from a single application of compost is expected to last 30 to 100 years, so that each year, as an additional 5 percent of California rangelands is treated with compost, an additional volume of carbon dioxide is removed from the atmosphere equal to that already being removed on the original treated area, and this removal continues in year 3, 4, 5, etc. In addition, we have our agricultural and forest lands, which can also be managed for enhanced capture of atmospheric carbon. There are also a number of other strategies to combine with compost applications to increase the rate of carbon sequestration on public lands, including restorative grazing practices.

We must recognize that reducing emissions alone will not stop and reverse global warming; we must capture and beneficially sequester atmospheric carbon. The Marin Carbon Project is not suggesting all public lands should be turned over to grazing or to compost applications. Rather, our work shows that land can be actively managed for enhanced carbon sequestration, thereby make a significant contribution to the reversal of the climate crisis, and that there are a host of ecosystem benefits attendant to doing so.

Thank you very much for the opportunity to participate in this critically important discussion. Please do not hesitate to contact me with further questions on this matter.

Sincerely,

JEFFREY A. CREQUE, PH.D.,
CA State Board of Forestry CRM-75,
Director, Rangeland and Agroecosystem Management.

[LIST OF DOCUMENTS SUBMITTED FOR THE RECORD RETAINED IN THE COMMITTEE'S OFFICIAL FILES]

Memo dated April 2, 2013 from Sierra Club Grazing Core Team to Sierra Club staff & volunteers, regarding Allan Savory's proposed application of "Holistic Management" to grasslands, including desert grasslands, for the purpose of increasing sequestration of atmospheric carbon.

The following articles on the subject matter have been submitted for the record:

- Ecological Society of America, *Ecological Applications,* (2013) 23(1), pp. 46–59, "Effects of organic matter amendments on net primary productivity and greenhouse gas emissions in annual grasslands," by Rebecca Ryals and Whendee L. Silver.
- Ecosystems (2013) 16: 962–979, "A Lifecycle Model to Evaluate Carbon Sequestration Potential and Greenhouse Gas Dynamics of Managed Grasslands," by Marcia S. DeLonge, Rebecca Ryals, and Whendee L. Silver.
- Elsevier, *Forest Ecology and Management* (2014) 329: 30–36, "Long-term livestock grazing alters aspen age structure in the northwestern Great Basin," by Robert L. Beschta, et al.
- Elsevier, *Global Environmental Change* (2013) 23: 240–251, "What can ecological science tell us about opportunities for carbon sequestration on arid rangelands in the United States?," by Kayje Booker, et al.
- Elsevier, *Soil Biology & Biochemistry* (2014) 68: 52–61, "Impacts of organic matter amendments on carbon and nitrogen dynamics in grassland soils," by Rebecca Ryals, et al.
- Environmental Management (2013) 51: 474–491, "Adapting to Climate Change on Western Public Lands: Addressing the Ecological Effects of Domestic, Wild, and Feral Ungulates," by Robert L. Beschta, et al.
- Hindawi Publishing Corporation, *International Journal of Biodiversity* (2014) Article ID 163431, "Holistic Management: Misinformation on the Science of Grazed Ecosystems," by John Carter, et al.

- *Rangeland Ecology & Management* (2008) 61: 465–474, “Carbon Fluxes on North American Rangelands,” by Tony Svejcar, et al.
- *Rangeland Ecology & Management* (2013) 66: 512–528, “Climate Change and North American Rangelands: Assessment of Mitigation and Adaptation Strategies,” by Linda A. Joyce, et al.
- The Society for Range Management, *Rangelands* (2013) 35(5): 72–74, “The Savory Method Can Not Green Deserts or Reverse Climate Change,” by David D. Briske, et al.
- University of Wyoming (2010) B–1203, “Grazing Influence, Objective Development, and Management in Wyoming’s Greater Sage-Grouse Habitat With Emphasis on Nesting and Early Brood Rearing,” by Jim Cagney, et al., available at http://www.blm.gov/pgdata/etc/medialib/blm/wy/resources/efoia/IBs/2010.Par.88692.File.dat/wy2010-022atch1.pdf.